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EDITORIAL

This first issue of the 1979 volume of the Virginia Journal of Science comes with a new editor, a new printer, a new format, and over a year late. During 1980 we will make a strong effort to print 8 issues, bringing the Journal back up to date. This can be done, however, only with the vigorous support of the membership.

We urge members to give the Journal serious consideration as the place of publication of their and their students' research reports. We urge authors to submit manuscripts that are carefully written and typed, with figures and tables well-organized and neatly prepared, so that review time and revision time can be cut to a minimum. We ask that reviewers do their work as quickly as possible after receiving manuscripts, and that authors revise reviewed manuscripts as quickly as possible. All this will reduce turnover time and allows us to have enough high quality manuscripts to turn out issues at high frequency during 1980.

Under the vigorous leadership of Business Manager, Frank Kizer, the Journal has resumed its policy of carrying advertising. We hope members will take note of our advertisers and respond positively to this gesture of support on their part. If our business members, or officers of non-member businesses would be at all interested in supporting the Academy and its Journal through advertising, we urge you to let our business manager know of this interest, and he'll contact you about details.

We reiterate: our greatest immediate need is good manuscripts. Read our instructions to contributors and let us hear from you.

Distribution and Nature of Carolina Bays on the Eastern Shore of Virginia

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Abstract—Carolina bays are prominent geomorphic features of the Eastern Shore of Virginia. These land forms occur from sea level to the highest elevations on the peninsula. Most bays are located along the central part of the mainland. Bays appear to be surface features which are underlain by similar sand strata at depths of 2 to 4 m. The occurrence of bays on Pleistocene terraces of different elevations suggests multiple periods of bay formation. Tidal march encroachment into Carolina bays indicates they are relic landscape features.

Introduction

Carolina bays were noted on Virginia's Eastern Shore in an early soil survey (USDA, 1920), which reported the level topography is broken by low ridges that enclose basin-like depressions. These basins have also been referred to on the Eastern Shore as whale wallows and Maryland Basins (USDA, 1970). Carolina bays are wet, shallow elliptical depressions with a parallel orientation in a NW-SE direction. They occur along the Atlantic Coastal Plain from Florida to New Jersey with estimates of perhaps a half million such features (Prouty, 1952).

Theories of Bay Origin—One of the earliest reported scientific works to draw attention to these peculiar basin-like depressions concerned bays in South Carolina (Toumey, 1848). He suggested the bays were formed by the action of springs rising to the surface of a sandy plain. Later work advocated an origin due to the actions of winds and waves on sand bars of shallow coastal embayments producing depressions enclosed by sand ripples (Glenn, 1895).

The term "Carolina bay" apparently was proposed in 1933 to refer to the oval or elliptical bays enclosed by low sandy ridges (Melton and Schreiever, 1933). The term originated because the depressions were first studied in the Carolinas where they were noted to widely occur, and because the basins commonly contain bay trees (Frey, 1949). Later publications proposed the term Neptune rings to describe the unusual depressions (Cooke, 1945), but Carolina bays apparently was the preferred description of the scientific community.

World attention was attracted to the subject when Melton and Schreiver (1933) proposed a meteoritic origin for Carolina bays. These workers proposed the bays were formed by the infall of meteorites of a probable cometary mass travelling in a southeast direction and hitting the earth at a low angle to the horizontal. Contrasting theories concerning the origin of the bays were proposed by C. W. Cooke (1933) who interjected new ideas into the controversy. Cooke proposed that bays are formed through construction of crescentic keys and segmented lagoons via forces of a dominant southeast wind. He proposed the wind created elliptical currents that scooped out elliptical depressions with the long axis parallel to the direction of the wind. Melton (1934) contested the views of Cooke. He proposed that if the meteoritic theory was untenable, his next choice was bay formation by submarine scour resulting from eddies, currents or undertow. MacCarthy (1937) reported Carolina bays were formed by the shock-waves accompanying a shower of large meteorites upon the earth. He further stated that bays are much larger than the meteorites that produced them. Later, Cooke (1940, 1954) proposed a new theory stating that bays were created in any confined body of water by the formation of elliptical eddies directed through gyroscopic effects of the earth's rotation.

Other interesting theories to account for the origin of Carolina bays developed in the decades of the 1930's through the 1950's. Johnson (1936) purported that Carolina bays are essentially the product, either directly or indirectly of solution, and the encircling rims represent accumulations of wind drift sand. Later, he proposed a new theory of bay origin that included the upwelling of artesian springs in association with ground water to produce circular rims (Johnson, 1942). A unique theory also involving artesian springs was advanced by Grant (1945), who proposed that hovering activities of spawning schools of fish are responsible for the formation of the shallow sand-rimmed depressions. Supposedly, such activities occur where artesian springs of fresh water appear in near-shore marine areas.

Thom (1970) reported a relationship between bay size and shape, and the size of the undissected Coastal Plain interfluves. He postulated bay formation by the expansion of shallow water bodies influenced by strong unidirectional winds during the Wisconsin Glaciation. Studies in North Carolina (Bryant and

McCracken, 1964) indicated that Carolina bays and associated inter-bay soils had similar parent materials, but bay soils were apparently younger. Recently, Gamble, Daniels and Wheeler (1977) reported many bays in North Carolina had secondary rims overlying a primary rim indicating more than one period of bay development.

A novel theory recently advanced to account for the formation of Carolina bays suggests they may be due to the impact of antimatter (Baxter and Atkins, 1978). It was suggested that minute scraps of antimatter striking the earth could leave impact features (bays) without any trace of the causal agent.

Few reports have been directed at Carolina bays on the Eastern Shore of Virginia. Cooke (1954) reported that Half Moon Bay and Island Bay in Accommack County resulted from the action of tidal eddy currents. He further stated that all known ellipitical ridges in Virginia and Maryland lie below 2 m elevation. Sinnott (1953) reported numerous Carolina bays occurred along the peninsula. The present study was conducted from 1972-1975. It initiated as a part of a comprehensive research project in remote sensing in agriculture. The objectives of this study were to investigate Carolina bays using remote sensing imagery, and to determine their relationships to soils and local geomorphology.

Study Area

The study area is located in Accomack and Northampton Counties, Virginia (Fig. 1). Forming the lower part of the Delmarva Peninsula, these counties are commonly referred to as the Eastern Shore of Virginia. The area is bounded on the east and south by the Atlantic Ocean, on the west by Chesapeake Bay, and on the north by the state of Maryland. The counties comprise of land area about 1,767 km². The mean width of Accomack, the upper county, is about 12.9 km, and Northampton County has an average width of about 9.6 km. The two-county Virginia portion of the peninsula tends northeast-southwest and is about 120 km long.

The area consists of the mainland, the offshore barrier islands, and the salt marshes and lagoons. Few points exceed 17 m elevation above mean sea level. The drainage divide bisects the counties, diverting the drainage on the eastern side to the Atlantic Ocean, and on the western side to Chesapeake Bay. The principal drainage consists of tidal estuaries, locally called creeks. The mainland consists of a series of Pleistocene terraces. The Talbot terrace (7.5-13.5 m) comprises the central portion of the peninsula (Sinnott and Tibbits, 1961). It is bordered by the lower Princess Anne (1.5-4.5 m) which includes elements of the Dismal Swamp terrace (4.5-7.5 m). Steam dissection has not affected large segments of these terraces.

Both counties lie within the Coastal Plain Province. The soils have developed in thick marine sediments. Gravimetric surveys indicate about 1,220 m of sediments overlie basement rock in the Exmore-Melfa

FIG. 1—Location of study area and sampling sites.

area, and the thickness increases near Wallops Island (Johnson and Sweet, 1970).

Methods

Imagery—Photographic analyses were made of NASA infrared photography (June, 1971) covering the two-county area. Imagery was obtained from an RC-130 aircraft at 3646 m altitude using a Wilde RD-8 camera with a Wratten 12 × 2.2 AV filter and Kodak Aerochrome color infrared film. Positive transparancies were 22.5 × 22.5 cm with an approximate scale of 1:20,000. High altitude color infrared imagery taken at an altitude of 19,803 m aboard a NASA U-2 aircraft (January 1972) was also used in the study. A photointerpretative inventory of Carolina bays was made using a Richards light table.

Soils—A field survey was made of the mainland and selected offshore islands. Soil investigations were made on 40 Carolina bays located at elevations from sea level to 17 m with soil auger and pits using standard methods (USDA, 1951). Four bays were sampled for laboratory analysis. Soil particle size distribution was determined by the pipette method (Day, 1965) and coarse fragments (> 2 mm) by sieving. The clay fraction was separated and analyzed by X-ray diffraction according to the methods of Jackson (1956). A General Electric XRD-5 X-ray instrument was used with $C\mu$ K$\propto$ radiation generated at 40 kv, 20 mA and a scanning speed of $2°$ per minute.

Soil pH was determined in a 1:2 soil-solution mixture with a Sargent Model DR pH meter. Organic

matter was determined by the method of Peech and others (1947). Exchangeable acidity was determined by the baruim chloride-triethanolamine method (Peech, 1965) and exchangeable aluminum was determined following the procedure of Yuan (1959). Exchangeable cations were extracted with N NH_4OAc at pH 7 (Chapman, 1965) and determined with the Perkin-Elmer Model 303 atomic absorption spectrophotometer.

Results and Discussion

Over 150 landscape features were identified by imagery evaluations and classified as Carolina bays following field investigations. The basin-like depressions occurred from the lower salt marshes to the higher elevations of the mainland. Bays were most numerous on the higher central terraces and they had a similar orientation. The bays ranged in shape from circular to ellipsoidal, and in size from about 150 m to 1.6 km. In a related study Bliley (1974) determined the bays had a mean orientation of 299° and he suggested these may be more rounded than bays reported in the Carolinas. In places, bays occurred in clusters, often bounding or overlapping each other. Bays with multiple and incomplete rims were common.

The outer rims ranged from 1 to 4 m higher than the central basins. The rims have lighter colored tonal patterns that contrast with the darker, wetter bay centers which enhances photographic detection (Fig. 2). Although surface drainage patterns and wet soils occurred adjacent to many of the bays, they could be readily delineated. However, bays located entirely in densely wooded areas of uniform vegetation were very difficult to recognize, and stereoscopic coverage was useful in detecting the elevated rims.

Marked vegetation differences were associated with the Carolina bays located in the marshes near sea level.

Fig. 3—Carolina bays located in the tidal marsh near Guard Shore showing partial bays and road located on the rim of a bay (infrared imagery).

Woody vegetation, including pine trees, commonly occur on the higher, better drained rims of bays in contrast to the wet tidal marsh bay centers (Fig. 3). These vegetative differences are readily detected on the color infrared photographs.

Although the larger bays could still be detected on the infrared imagery taken at 19,803 m (Fig. 4), many

Fig. 4—Image of the southern portion of the Eastern Shore obtained via U-2 aircraft (infrared imagery) showing Carolina bays (Approximate Scale 1:37, 150).

Fig. 2—Carolina bay at higher elevation with light colored rim and dark center (infrared imagery).

of the smaller bays could not be identified without considerable magnification. The panoramic view produced by the high altitude imagery is conducive to delineate the occurrence pattern of the bays. It was difficult to detect bays on ERTS satellite imagery obtained from 886 km in space.

Soils—Pedological differences exist between soils of Carolina bays at higher elevations and those located near sea level. The rims of mainland bays had well-drained soils with centers of somewhat poorly and poorly drained soils. During field studies in the spring of 1973, the ground water table of rim soils was not detected within 175 cm of the surface, whereas it occured in the upper 50 cm of soils comprising the interior part of the bays. Generally, rim soils exhibited greater pedogenic development than centers as reflected by brighter colors, clay movement-accumulation and distict horizonation. Soils in bay centers were darker colored and contained higher silt and organic matter content than rim soils.

In contrast, soil comprising the rims of bays near sea level had must less pedogenic development and horizonation. Soils were stratified and undifferentiated in the bay centers with mucky surfaces and high silt contents indicating recent deposition. The water table was encountered at depths of 75 to 125 cm in the rim soils. The bay centers are flooded at high tide and appear to be continuously saturated. Soil development in bays near sea level indicate much younger soils as evidenced by pedogenic features.

Coarse fragments were absent in the bay soils examined except for bays in the coastal marsh near Guard Shore (Table 1). These coarse fragments were smooth, rounded quartz pebbles ranging from 2mm up to 5 cm in diameter. Bay rims contained more sand and less silt than centers indicating greater depositional energy.

Both rims and centers had sandy textures at depths greater than 2 to 3 m, as did adjacent soils. A yellowish-brown to gray sandy stratum was observed under all bays examined in both counties.

Bay soils at higher elevations were acid, except where heavily limed, in contrast to bay soils near sea level which were neutral reflecting the salt water influence. The mainland bay soils were very low in extractable bases (Table 2) in comparison to those near sea level. Low levels of exchangeable aluminum were detected in rim and depression soils.

The clay fractions of rim and depression soils at higher elevations consist of kaolinite, vermiculite-chlorite integrade, quartz, and minor amounts of mica and gibbsite. Bays near sea level had clay fractions consisting of kaolinite, vermiculite, mica, vermiculite-chlorite integrade and quartz with significant amounts of montmorillonite in subsoils of the bay centers. The mineral content was more variable in the lower-lying bays. Greater gibbsite contents were detected in the lower horizons of bay rim and depression soils at higher elevations. Gibbsite is often associated with older weathered soils or intense weathering. The montmorillonite in centers of bays near sea level may be recent deposition of Chesapeake Bay sediments. The sand and silt fractions of bay rims and depressions were dominated by quartz with trace amounts of feldspars and mica.

Land Use—Interesting land use practices appear to be associated with the Carolina bays. In the lower coastal marsh areas the higher rims are utilized as parts of roads (Fig. 3). Cemetaries and buildings were also constructed on the rims throughout the peninsula (Fig. 5). Lack of natural drainage in the oval depressions was remedied in cultivated areas by ditches and excavations through the surrounding rims to an outlet. The

Table 1.   Particle size distribution of representative rim and depression soils of selected Carolina bays at different elevations on the Eastern Shore.   Samples were taken from the top center of the rims and the center of the depressions.

Elevation m	Depth cm	Coarse Fragments (>2 mm) %		Sand (2-.05 mm) %		Silt (.05-.002 mm) %		Clay (<.002 mm) %	
		Rim	Depression	Rim	Depression	Rim	Depression	Rim	Depression
15 (Nelsonia)	0-20	–	–	61.7	61.2	27.6	25.9	9.7	12.8
	125-150	–	–	84.3	47.6	5.6	30.4	10.2	21.9
	250-275	–	–	>95	>95	–	–	–	–
12 (Eastville)	0-20	–	–	71.9	60.1	21.9	29.9	5.8	10.0
	125-150	–	–	71.8	73.6	17.7	14.5	10.5	11.8
	250-275	–	–	>95	>95	–	–	–	–
10 (Bell Haven)	0-20	0.9	–	82.7	58.8	13.0	30.4	4.2	10.7
	60-80	–	–	77.2	69.3	12.7	28.9	10.1	1.7
	125-150	–	–	97.9	92.7	1.4	2.7	0.9	4.5
	250-275	–	–	>95	>95	–	–	–	–
2 (Guard Shore)	0-20	7.1	1.0	70.6	20.5	23.9	47.0	5.5	32.4
	125-150	17.5	6.3	65.2	16.2	19.6	58.9	15.1	24.8
	250-275	–		>95	–	–	–	–	–

Table 2.   Chemical characteristics of representative rim and depression soils of selected Carolina bays at different elevations on the Eastern Shore.

Elevation m	Depth cm	pH	Organic Matter %	Exchangeable Cations meq/100g				Extractable Acidity meq/100g
				Ca	Mg	K	AL	
			Rim Soils					
10 (Nelsonia)	0-20	5.3	0.4	0.31	0.01	0.03	0.04	3.38
	50-60	5.5	0.1	1.45	0.28	0.10	0.09	2.34
	125-150	6.6	-	0.17	0.02	0.01	-	0.94
12 (Eastville)	0-20	6.6	0.3	1.45	0.70	0.44	-	3.21
	125-150	6.4	-	1.95	0.40	0.10	-	2.69
2 (Guard Shore)	0-20	4.6	0.7	0.10	0.72	0.28	0.52	5.47
	125-150	5.1	-	1.65	2.24	0.23	0.50	4.08
			Depression Soils					
10	0-20	4.7	1.2	0.17	0.02	0.13	1.80	11.70
	50-60	4.8	0.1	0.60	0.11	0.11	1.30	4.18
	125-150	4.9	0.1	0.12	0.01	0.03	0.03	2.34
12	0-20	6.1	0.9	0.72	0.42	0.10	0.80	2.21
	125-150	4.8	0.1	0.64	0.23	0.11	1.20	3.56
2	0-20	6.9	11.2	4.00	29.00	3.75	0.17	15.01
	125-150	6.8	0.2	1.20	4.00	0.50	-	2.86

droughty nature of the higher sandy rims often necessitates different agronomic practices. Intensive mechanized cultivation appears to be gradually leveling the rims and filling the bay centers, thus making them more difficult to recognize (Fig. 6).

Carolina bays on the Eastern Shore seem to be stable except for erosion due to cultivation and cultural activities and erosion by tidal waters. The presence of old cemetaries and buildings over a century old on rims support this premise. Topographic bench marks and aerial photographs also indicate the stability of bays over the past three decades.

FIG. 5—Cemetary located on higher, well drained rim of a Carolina bay with road cutting through the rim.
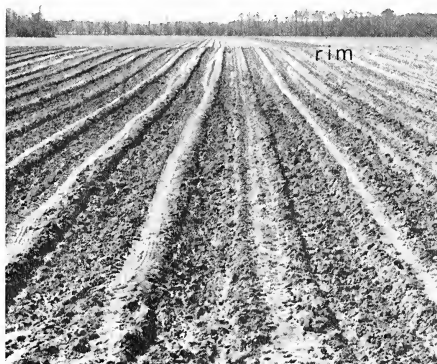

FIG. 6 —Cultivation across center and rim of Carolina bay as seen looking from the outside due South over the rim toward the center. Potato rows are about 1 m apart. Rims are gradually being worn down by intensive cultivation.

Bays and Geomorphology—Carolina bays occur on the Eastern Shore in a definitive pattern (Fig. 1). A majority of bays are on the Talbot terrace along the central portion of the peninsula. Many bays occur on the narrow segment of the Princess Anne terrace (Fig. 1, insert A). Groups of bays are located in the northwestern part of the study area in tidal marshes along Chesapeake Bay (Fig. 1, inset B). This area contains the largest bays although many of them do not have complete rims.

More bays were detected in Accomack than in Northampton County. The Talbot surface is wider in Accomack County and presented a larger stable land surface for bay development. The size of the terrace surface appears to have an influence on the extent and size of the bays. Eleven bays were identified on Bradford Neck between Wachapreague and Quinby and three bays on Upshur Neck south of Quinby. Bradford and Upshur Necks are narrow necks separated from the eastern mainland by tidal streams and bounded on the east by recent tidal marshes and lagoons. The bays are small and in proportion to the narrowness of the land surface. The western ends of these bays have been truncated by the Machipongo River or other streams.

About 25 partial bays were identified in the tidal marshes of Chesapeake Bay between Deep Creek and Sanford. Many of these bays have a crescent shape with incomplete rims. The rims are sandy and contain more woody vegetation than the tidal marsh centers and surrounding area. The marsh sediments are silty and contain large amounts of organic matter. The marsh appears to be breaching the pre-existing bay rims and gradually destroying or inundating them. The marshes are apparently recent and developing in response to rises in sea level (Oaks and Coch, 1963). The isolated bay rims surrounded by tidal marsh represent older land surfaces related to higher energy depositional levels than are present in the present marsh environment.

Carolina bays are conspicuously absent along the eastern Atlantic barrier islands and associated marshes and lagoons. However, this is expected because the barrier islands are dynamic Holocene land-forms. Presumably, any pre-existing bay landforms would have been masked or obliterated by the present dynamic off-shore islands and marsh. It is also envisioned that a suitable, stable landform would be necessary for a considerable time period for bay development. No evidence was observed that would indicate Carolina bays are currently forming in the sandy coastal plain Holocene (recent) sediments.

Summary

In contrast to earlier reports (Cooke, 1954), this study shows that Carolina bays occur on the Eastern Shore from sea level to the highest elevations. They are prominent geomorphic features. Most bays occur on the higher elevations along the Central part of the mainland. Carolina bays in the study area are less elliptical than bays reported in North and South Carolina.

The absence of detectable continguous calcareous strata near the surface and the great sediment thickness over basement rock tend to discount earlier solution theories of bay formation. Our physical, chemical and mineralogical data were limited to shallow depths, but no evidence of a meteoric bay origin was detected. The presence of bays at various elevations on different stratigraphic units strongly suggests different periods of bay formation. The occurrence of bays below a scarp near Wachapreague indicates they are younger than bays at higher elevations. Brighter soil colors and greater pedogenic development in bays at higher elevations also suggest they are older.

Current bay destruction by marsh encroachment and lack of evidence for current bay formation indicate they are relic landscape features. The presence of similar sand strata at depths of 2 to 4 m underlying bays at different elevations suggests they are surface features. The higher sandy rims have a "dune-like" appearance which are suggestive of wind action.

Carolina bays on the Eastern Shore appear to have formed in sandy surficial sediments of larger terraces that were stable and undissected for a considerable time period.

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The Effect of a Thermal Discharge on the Benthos of a Virginia Creek

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Abstract—The Columbia Gas Transmission Corporation, Gala Compressor Station has been using water from Mill Creek in Botetourt County, Virginia, to cool the compressor engines since 1940 at an estimated rate of 1.3×10^{-2} cms to 6.6×10^{-2} cm. A May-October (1976) investigation of the benthic communities and the thermal regime of Mill Creek indicated the following: Stream discharge ranged from 1.12×10^{-1} cms to 2.76 cms while cooling water use ranged from 1.68×10^{-2} cms to 4.8×10^{-2} cms. A total of 74 genera of benthic macroinvertebrates was collected during the course of this study. Forty-eight taxa were recorded from the downstream-pool-stations, 43 from upstream-pool-stations, 49 from downstream-riffle-stations, and 57 from upstream-riffle-stations. Mean downstream benthic densities ranged from $473/m^2$ to $5371/m^2$ while mean upstream benthic densities ranged from $204/m^2$ to $2938/m^2$. Mean downstream benthic taxa ranged from 3 to 12 while mean upstream benthic taxa ranged from 2 to 16. Mean downstream diversity ($\bar{d}$) estimates ranged from 1.157 to 2.421 while mean upstream diversity ($\bar{d}$) estimates ranged from 0.549 to 3.254. Differences were not significant (p = .05). The greatest increases in stream temperature were recorded July 27 and August 31 when a 4.9 and a 10.1°C, respectively, difference existed between ambient upstream temperature and the riffle transect 15m downstream from the discharge. The high stream discharge of the October sampling effectively "scoured" the stream bottom and resulted in very low benthic densities at all sampling stations.

Introduction

There have been many large scale studies in recent years to monitor the effects of heated-water discharges to major waterbodies (Coutant and Talmadge, 1977). Also, two bibliographies, Kennedy and Mihursky (1968) and Raney *et al.* (1973) are available which review the effects of heated discharges on aquatic organisms. Most thermal impact studies in the past have dealt with relatively large projects, i.e., thermal discharges from nuclear power plants to rivers, lakes, or estuaries. One of the most recent and rigorous investigations of such a project is The Connecticut River

Ecological Study, The Impact of a Nuclear Power Plant (Merriman and Thorpe, 1976). In this study, cooling water use was 23.5 cms, while the river had a monthly discharge of 333 cms. Studies of small scale thermal discharges are usually limited to laboratory designs in highly artificial (as well as highly controlled) situations. A relatively limited heated-water discharge to a small Virginia stream presented the opportunity to monitor the response of the benthic community in the vicinity of this effluent.

The Columbia Gas Transmission Corporation, Gala Compressor Station has been using water from the adjacent Mill Creek in Botetourt County, Virginia, to cool compressor engines since the facility was constructed in 1940. Cooling water use ranges from 1.3×10^{-2} cms 6.6×10^{-2} cms. Water temperatures of the cooling water are increased and discharged back into Mill Creek approximately 46 m downstream from the intake source. Water temperatures at the discharge pipe range between 27 and 54°C. Discharge rate is estimated to average less than 2.8×10^{-2} cms. The discharged water falls approximately one meter into a rock-lined channel which parallels the stream and enters Mill Creek from the north bank. The thermal plume is generally restricted to the north bank for the first 15 m until the first major riffle is approached, where the water masses begin to mix.

Study Area

Mill Creek is a tributary of the James River with headwaters in the Jefferson National Forest near the Botetourt-Rockbridge County line (Fig. 1). It is a second-order stream with a gradient of approximately 10.0 m/km in the vicinity of the study area. The chan-
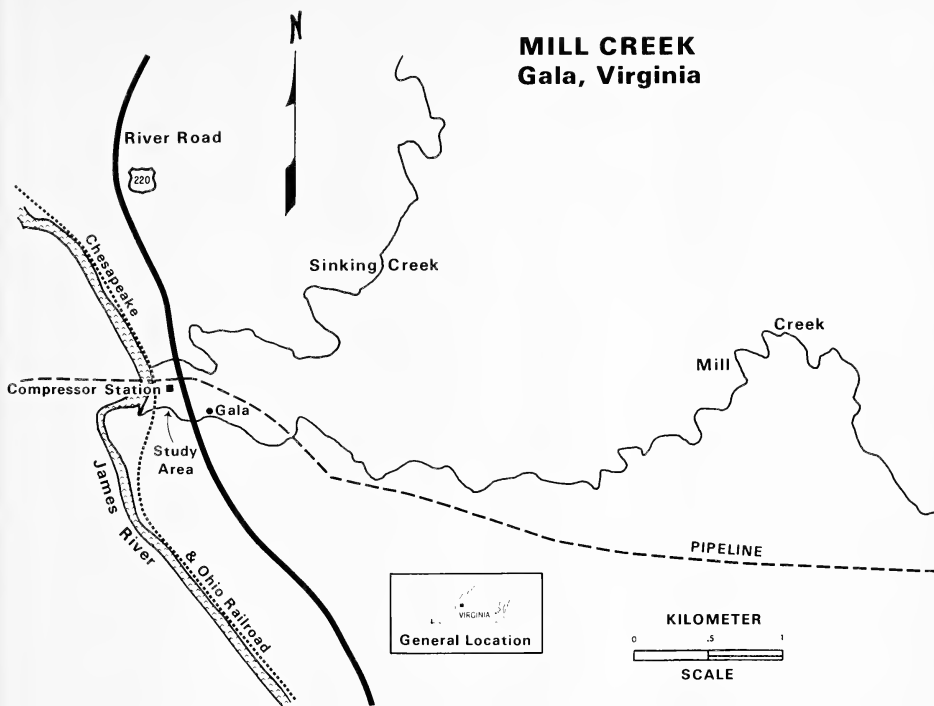
Fig. 1—Map of study area, general location.

nel width within the study area ranges between 9.8 and 5.0 m with an average depth of 0.2 m. Substrate consists of boulders, cobbles, and sand with very little silt and detritus except in quiet pools at bridges. The study site consists of a series of long riffles and shallow pools. Stream discharge ranges between 1.13×10^{-1} and 2.76 cms as estimated by the floatation method of Robins and Crawford (1954).

Stream border vegetation is dominated by sycamore *(Platanus occidentalis)*, river birch *(Betula nigra)*, willow *(Salix sp.)*, alder *(Alnus sp.)*, honeysuckle *(Lonicera japonica)*, and assorted perennials.

Methods

Four transects were established at the study site: one "riffle" transect approximately 15 m downstream and one "pool" transect approximately 7.5 m downstream from the heated discharge with a "riffle" and a "pool" transect at approximately equal distances upstream from the heated discharge for "control" samples (Fig. 2). One Surber (1024 μ net mesh) sample was taken at two shore and one mid-steam station along each transect once each month from May 1976 through October

1976. Samples were fixed in 70% ethanol for subsequent identification and enumeration. Water temperatures were recorded at each benthos sampling station. Stream discharge was estimated by the floatation method of Robins and Crawford (1954).

Stream temperatures were recorded with a Digimite Temperature Indicator Model 31160-2-4-0313, Thermo-Electric Co., Saddlebrook, New Jersey. Surface and bottom temperatures were measured, beginning at the input source and continuing at 0.3 m intervals downstream to determine the length of the plume. Temperature profiles were also measured at 0.3 m intervals transversely on transects located 1.5 m apart to describe the width of the thermal plume. Temperatures were recorded downstream until the 1°C above-ambient temperature was recorded.

Stream temperatures at the mouth of Mill Creek (approximately 259 m downstream from the discharge point) and within the James River were also recorded at each sampling period. Ambient upstream temperatures were recorded several times during the thermal data collection to compensate for natural daily rises in stream temperatures during the monitoring interval.
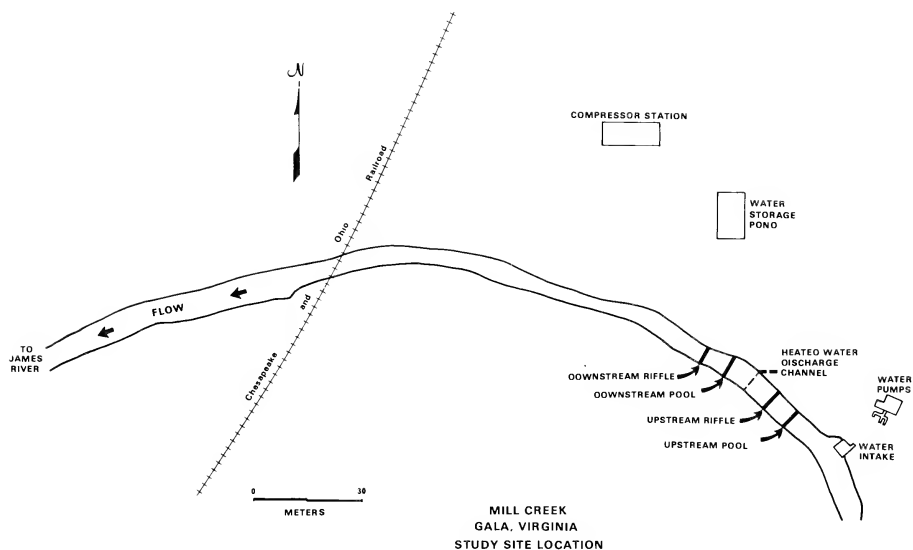
FIG 2—Study site transect locations.

TABLE I

Water Temperatures of Mill Creek and Study Transects
(7.5 and 15 m downstream from heated discharge), Gala
Virginia, Botetourt County, 1976

Date	$\bar{x}$ Upstream Temperature (^{O}C)	$\bar{x}$ Downstream (^{O}C) Pool	$\bar{x}$ Downstream (^{O}C) Riffle	Max. Δ t (^{O}C)	Stream Discharge (cms)
May 26, 1976	15.8	18.7	18.3	2.9	0.36
June 29, 1976	20.1	20.6	20.1	0.5	0.62
July 27, 1976	22.2	27.1	26.5	4.9	0.16
August 31, 1976	16.2	26.3	25.2	10.1	0.11
September 28, 1976	17.8	19.3	19.3	1.5	0.15
October 27, 1976	7.8	7.8	7.8	0.0	2.76
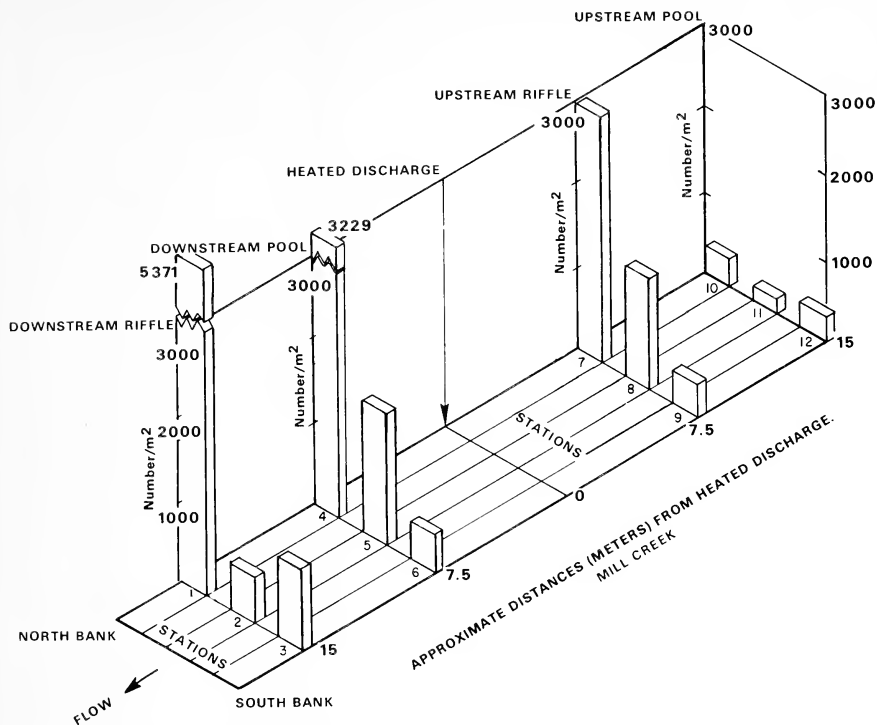
FIG. 3—Mean numbers of benthic organisms per square meter at stations above and below heated discharge, Mill Creek, Botetourt County, Virginia, May-October 1976.

Results and Discussion

Table 1 summarizes the upstream Mill Creek temperatures relative to the downstream pool and riffle transects. It can be seen that the dates of July 27 and August 31 indicate 4.9°C and 10.1°C increases above ambient upstream temperatures, respectively.

A total of 74 genera of benthic macroinvertebrates was collected during the course of this study. Insects accounted for 60, mollusks 6, crustaceans 2, nematodes 1, oligochaete worms 2, hydra 1, horsehair worms 1, and planaria 1. Forty-eight taxa were recorded from the downstream-pool-stations, 43 from the upstream-pool-stations, 49 from the downstream-riffle-stations, and 57 from the upstream-riffle-stations.

Fig. 3 presents the mean numbers of benthic organisms collected per square meter at stations above and below the heated discharge for the study period May-October, 1976. Mean benthic densities ranged from 473/m² to 5371/m² at downstream stations and 204/m² to 2938/m² at upstream stations.

Five orders of invertebrates comprised more than 97% of the total specimens collected: Plesiopora (Oligochaeta) 58.1%, Ephemeroptera 14.8%, Diptera 13.8%, Trichoptera 9.0%, and Coleoptera 2.2%. Table II lists the twenty most common invertebrates and compares the numbers between upstream and downstream sampling stations. Numbers of *Pseudocloeon* were four times greater at the downstream sampling stations. However, more than half of these were collected in the May sample before any great changes in water temperatures were evident. *Hexagenia,* (a burrowing mayfly) was found at one downstream station once, and none was recorded at an upstream station. *Stenonema, Isonychia, and* Caenis were the genera occurring in significant numbers. Oligochaeta were represented in over 79% of the samples but were much more abundant downstream with the majority being members of the family Tubificidae.

In the dipteran genera, no great disparity in numbers was noted between the upstream and down-

TABLE II

Twenty Most Common Benthic Invertebrates Collected Per Six Surber Samples,
Comparison of Upstream and Downstream Sampling Sites in Descending Order
of Abundance Mill Creek, Gala, Virginia. May - October, 1976

Taxa	Downstream No. Specimens	Upstream No. Specimens	Total No. Specimens
Oligochaeta	5551	109	5660
Chironomidae	642	576	1218
Stenonema	33	613	646
Hydropsyche	103	294	397
Isonychia	32	231	263
Chimarra	1	170	171
Hydropsychidae[a]	19	129	148
Cheumatopsyche	3	113	116
Heptageniidae[b]	1	107	108
Pseudocloeon	87	20	107
Psephenus	28	78	106
Caenis	16	83	99
Leuctra	6	73	79
Ferrisia	45	27	72
Simulium	42	27	69
Optioservus	30	38	68
Epeorus	13	39	52
Ephemerella	29	18	47
Heptagenia	3	37	40
Paraleptophlebia	8	29	37

[a] This includes Cheumatopsyche and Hydropsyche. Individuals were too small to determine to genus.

[b] This includes both Heptagenia and Stenonema. Individuals were either too small to determine accurately to genus or gills were missing.

stream areas. One genus, *Blepharocera,* represented by only four specimens, was found only in downstream riffles in May. Single specimens in the genera, *Limonia* and *Tipula,* were found only at upstream sites.

Of the trichopterans collected, only the family Hydropsychidae (including the genera *Cheumatopsyche* and *Hydropsyche*) and the genus, *Chimarra (family Philopotamidae) occurred in significant numbers. The great majority of Chimarra* occurred at one upstream-riffle-station (117 of the 170 total) on one date, September 28. Only one specimen was found on this date at a downstream-riffle-station.

The most abundant coleopteran genus was *Psephenus* which was found in 14 collections downstream and 18 collections upstream with the greatest numbers in upstream riffles. The elmid *Optioservus* was second most abundant and was equally distributed between downstream and upstream sampling stations. Five other elmids and one dryopid comprised the rest of the beetle fauna.

Plecoptera, with the exception of *Leuctra,* represented a very small portion of the aquatic insect fauna. *Leuctra* was most abundant at the upstream sampling sites. The gastropod *Ferrissia* was the only mollusk collected with any frequency. The other four genera, *Mudalia, Lymnaea, Physa* and *Fontigens,* were rare.

Organisms which appeared to be the most tolerant to the heated water downstream zone were tubificid worms (Oligochaeta) where the greatest increases in temperature above-ambient were recorded. This was

the most apparent in the August collections when stream discharge was at its lowest, 1.12×10^{-1} cms. Chironomids also appeared to be tolerant of higher temperatures.

Diversity—Since it is generally true that relatively undisturbed environments support communities with many species with no one species in extraordinary abundances, it is worthwhile to compare the upstream and downstream benthic communities with a diversity index. The Shannon-Weaver index was chosen as recommended in the EPA Biological Field and Laboratory Methods (1973). Generally, $\bar{d}$ ranges between 3 and 4 with clean, favorable conditions, while $\bar{d}$ is usually less than one in polluted or stressed conditions (Wilhm, 1970).

Figure 4 presents the $\bar{d}$ estimates for the upstream and downstream benthos stations. Although the two riffle and pool areas of the stream are not morphometrically identical, it is felt that comparisons are valid and that major differences due to the heated discharge would be evident. In fact, the upstream riffle consists of a more diverse habitat of water velocities and sub-

strate types, while the downstream riffle consists mainly of a narrower "chute" dominated by boulders and cobbles. Also, the upstream riffle receives more solar radiation since the adjacent bank is where the water pump building is located; and stream border vegetation is, therefore, limited.

There are curious differences in upstream and downstream $\bar{d}$ estimates in July and August when stream discharges were very low (1.6×10^{-1} and 1.12×10^{-1} cms, respectively). At these times, the two downstream stations within the maximumly-heated north bank section recorded the two highest total organism counts ($31,172/m^2$ and $17,254/m^2$). However, both samples were dominated by oligochaete worms (associated with algae mats) with corresponding low diversity estimates.

A "t" test was used to evaluate mean numbers of taxa and mean ($\bar{d}$) estimates. The results showed no significant differences ($p = 0.05$) between upstream and downstream stations for the study period when samples were pooled.

The October 1976 stream discharge was high

DIVERSITY ($\bar{d}$) ESTIMATES FOR
UPSTREAM & DOWNSTREAM BENTHOS STATIONS
Mill Creek, Botetourt County, Virginia.
May-October, 1976
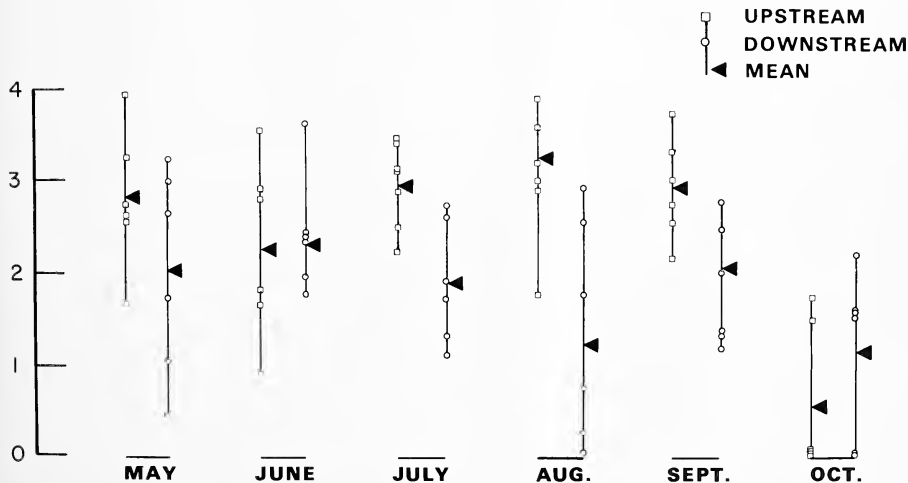
FIG. 4—Diversity (d) estimates for upstream and downstream benthos stations, Mill Creek, Botetourt County, Virginia, May-October 1976.

enough to remove the metal stakes which had been established at 30 m intervals in the stream channel. High stream discharges, while causing considerable consternation to the aquatic biologist attempting to study the stream, are natural phenomena in a stream's hydrologic cycle. Hynes (1970) discusses the reductions in abundance and diversity of benthic invertebrates resulting from high water. He cites many references from investigations throughout the world which have revealed the marked reductions in benthic densities following high water discharges. The phenomenon of "drift" usually results in rapid recolonization of the stream substrate when conditions have stablized.

Mann (1965) in a study of heated effluents and their effects on the invertebrate fauna of the river Thames considered the critical temperature for most benthic invertebrates to lie between 32° C and 35° C. The sampling in August recorded what was probably one of Mill Creek's lowest discharge rates (1.12×10^{-1} cms), and therefore, resulted in what is most likely the most stressful conditions in terms of departure from optimum biological conditions. Botetourt County experienced severe drought conditions in August 1976 and residents of the area noted that the Creek was flowing "as low as it had ever been." The September sampling indicated recovery of more favorable conditions for stream communities. Unfortunately, the flood conditions of October effectively obliterated the benthic communities in the study area, but it is probable that the upstream and downstream riffles would return to comparable conditions during the winter and spring months.

Although it is only conjecture, it is quite possible that the "warming effect" of the discharge upon the downstream pool and riffle could cause increased biological activity and possible early emergence of some insects. The net effect of this condition, of course, would depend on whether the increased production and early emergence resulted in more available forage for resident fish populations. It is probable, however, that this would be limited to a very small area of the stream since winter and spring downstream warming effects are rapidly attenuated when the thermal discharge is normally well below 2.8×10^{-2} cms.

It may be concluded that although there were differences between the upstream and downstream benthic populations, these differences were not major when compared over time. Certain organisms, (chironomids and oligochaete worms) appear to be particularly tolerant of increased stream temperatures, and found in abundance when there is a corresponding increase in algal production in the vicinity of the discharge.

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Forests of Small Stream Bottoms in the Peninsula of Virginia

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Abstract—A forest community small in extent but frequently encountered in the Virginia Coastal Plain is the bottomland forest of small streams. These long, narrow, flat areas along twisting and often braided streams are bounded by usually sharply rising slopes with a strikingly different forest type. Seventeen fairly mature small stream bottom forests were sampled by the Bitterlich method, and arranged in a Bray-Curtis type ordination. Most stands were dominated by some combination of red maple, ash (mostly *Fraxinus pennsylvanica*), and American elm. These stands, along with two dominated by baldcypress, fell in the upper right portion of the ordination. Stands with a high importance of American hornbeam and tuliptree fell in the lower middle portion of the ordination, and willow oak and sweetgum occupied the left side of the ordination. Swamp trees like water tupelo, water hickory, swamp cottonwood, silver maple, and box elder were absent from the sampled stands, though the first three do occur in some Peninsula of Virginia river swamps. Three other species often regarded as bottomland trees elsewhere in the Atlantic Coastal Plain (loblolly pine, beech, and sweetbay) were of low importance and are more abundant in uplands in the Peninsula.

Introduction

A forest type small in extent but frequently encountered on the Coastal Plain of Virginia is the bottomland forest of small streams. These long, narrow streamside forest communities have a high water table and/or experience temporary flooding at irregular intervals. The composition of the forest changes abruptly as one moves from the very level floodplain bordering the twisting and often braided streams onto the adjoining (and usually steeply rising) slopes, so the total area covered by the bottom forests is not great. Ecological studies have been made of Coastal Plain hardwood swamps in Alabama (Gemborys and Hodgkins 1971), Florida (Monk 1966), and New Jersey (Bernard 1963), but no such studies have been published on the Atlantic Coastal Plain between New Jersey and Florida. Though there have been geographically nearer studies that included small stream bottom forests, these were in the Piedmont (Oosting 1942 in North Carolina; Genborys 1974 in Virginia) or at the Piedmont-Coastal Plain boundary (Hotchkiss and Stewart 1947 in Maryland). The purpose of the present study was to determine the vegetational composition of small stream bottoms in the central Coastal Plain of Virginia, and to relate their composition to previous studies of similar communities elsewhere.

The Study Area

The area of study is located between the James and York Rivers in the Coastal Plain in James City, Charles City, and New Kent Counties, Virginia (Fig. 1). In this area, stream bottoms are less likely to show signs of recent disturbance than upland sites, for the bottoms are too wet for either cultivation or profitable pine production, and are frequently left unmolested. Despite the lack of recent disturbance, there are probably no virgin bottom forests. The timber of all sampled stands were clearly second growth. Even the largest trees encountered *(Taxodium distichum* in stand 11) were much smaller than some rotting stumps, presumably relics of a virgin condition, found in stands 4, 10, and 16.

A large number of small stream bottoms encountered in the study area, while showing no signs of recent timbering, were covered with standing dead trees. These areas, often partly flooded, were located where streams are crossed by fairly recently built
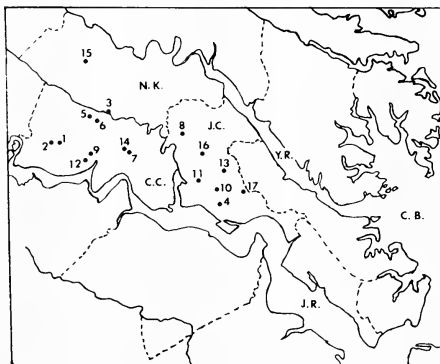

FIG. 1—Distribution of seventeen sampled bottomland stands in the Coastal Plain of Virginia. C. B. = Chesapeake Bay; J. R. = James River; Y. R. = York River; N. K., C. C., and J. C. are abbreviations for New Kent, Charles City, and James City counties.

highways. It seems probable that the recent death (within the last ten years) of the trees resulted from the disturbing action of roadbuilding, which may have drastically changed the moisture conditions. If the conduits under the road are insufficient to handle all the water flow during flood stages, the depth, frequency, and especially the duration of flooding may have increased greatly since the construction of the highways, causing massive tree die-off.

Methods

U.S. Geological Survey topographic maps were used to locate forested sites lying along non-tidal streams that were accessible from public roads. Sites were then visited to determine whether they were suitable for study. Stands were excluded if they appeared

recently disturbed, contained many dead trees, were not homogeneous, appeared to be permanently or semi-permanently flooded, or were too small to permit an adequate sample. Seventeen stands were sampled in the summer of 1975.

Dominance was measured (m^2/ha, cross-sectional area breast high) by the Bitterlich method, using a Spiegel Relaskop (sighting prism). The density of each species (tree/ha) was based on counts of stems ≥ 10.16 cm (4 in) dbh found in circular plots with a 10 m diameter. Relative dominance and relatively density were calculated and averaged to yield relative importance value (I.V.). Using the I.V. data an ordination of stands was established following the Bray-Curtis techniques as employed by Gemborys (1974). Because the third (Z) axis was essentially the same as the X axis, the

Table 1.   Species Ranking Among the Top Three in at Least

One of Seventeen Sampled Stands

Species	# Times Achieving Rank in Stand of			Stands With I.V. >10	# Stands Where Present	Maximum Importance Value
	1	2	3			
Acer rubrum	5	4	1	10	17	43.4
Fraxinus pennsylvanica	3	3	2	8	15	49.4
Liquidambar styraciflua	2	3	3	8	15	38.6
Carpinus caroliniana	2	2	2	7	15	26.9
Ulmus americana	-	-	4	5	14	17.0
Quercus phellos	2	-	1	2	9	64.2
Quercus michauxii	1	-	1	3	9	20.9
Taxodium distichum	1	1	-	2	3	30.7
Quercus nigra	1	-	-	1	3	23.4
Liriodendron tulipfera	-	1	1	2	10	17.9
Nyssa sylvatica	-	1	-	2	11	23.2
Fagus grandifolia	-	-	1	2	9	12.1
Ilex opaca	-	1	-	1	6	20.3
Betula nigra	-	1	-	1	5	20.2
Pinus taeda	-	-	1	1	11	17.4
Quercus pagodaefolia	-	-	1	0	6	8.2

ordination was established using only the X and Y axes.

Nomenclature follows Radford, Ahles, and Bell (1968). Ashes were identified as *Fraxinus pennsylvanica,* but the identifications were made in summer using vegetative characters, and while an autumn check revealed that all of the trees examined bore fruit of *F. pennsylvanica, F. profunda* fruits were found on the ground in two swamps, so this species may be included in some of our samples.

Results

Of the 34 species of trees found in the sampled stands, 8 species were leading dominants in at least one stand. Seven other species had an I.V. $>$ 10 in one or more stands (Table I). Stands 1 and 17 formed the two reference stands of the X axis, being 97.45 dissimilarity units apart. *Quercus phellos* (I.V. = 45.5) dominated the first reference stand, while *Fraxinus pennsylvanica* (I.V. = 49.4) and *Acer rubrum* (I.V. = 31.8) dominated the second reference stand. On the Y axis, 82.3 units long, stands #9 *(Carpinus carolinia,* I.V. = 26.9; *Ilex opaca,* 20.3) and #7 *(Liquidambar styraciflua,* 36.8; *Acer rubrum,* 23.4) were the reference stands. When species of high importance were plotted on the ordination, they tended to fall into one of three general areas on the ordination (Fig. 2). It should be emphasized that the spatial locations on the ordination are not necessarily of environmental significance, but show an abstract relationship based on the relative similarity of the stands to one another.

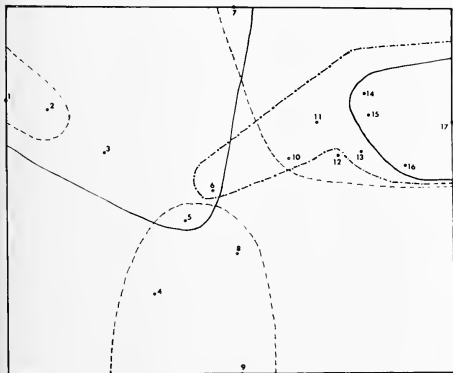Most stands were found in the upper right hand corner of the ordination. These stands were mainly

FIG. 2—An ordination showing areas of greatest importance of six major species. The solid line in the upper right enclosures those stands where *Ulmus americana* I.V. $\gg$ 11; the dot-dashed line encloses those with *Fraxinus americana* I.V. $\gg$ 14; the upper left solid line, *Liquidambar styraciflua* $\gg$ 12; the upper left dashed line, *Quercus phellos* I.V. $\gg$ 40; the lower central dashed line, *Carpinus cardiniana* I.V. $\gg$ 16.

dominated by *Acer rubrum,* and high importance values for this species show a distinct pattern of concentration in that area. *Fraxinus pennsylvanica, Ulmus americana,* and *Nyssa sylvatica* exhibited the same pattern of concentration in this portion of the ordination, and *Taxodium distichum* attained its only high values in two stands in this area. *Carpinus caroliniana,* on the other hand, had its highest importance values in stands located at the central lower area of the ordination. The less important species *Betula nigra* and *Fagus grandifolia* show the same pattern. *Ilex opaca* reached its only high I.V. there, and *Platanus occidentalis* is more consistently present here than elsewhere. *Liriodendron tulipifera* had its highest importance values in the lower middle area, but the values decreased gradually into the *Acer rubrum-* dominated upper right area.

A third region of concentration appears in the upper left portion of the ordination, where *Liquidambar styraciflua* and *Quercus phellos* have their highest I.V.'s *Quercus nigra* is a leading dominant in one stand there.

Quercus michauxii had at least one high importance value in all three 'corners' of the ordination, with no area of concentration. *Pinus taeda* was abundant in the upper central portion of the ordination, and therefore was dissociated from all three 'centers' of concentration.

Although stands in general were selected to have similar moisture conditions, there were moisture differences among our stands. Obvious differences were noted qualitatively, but these subjective judgments are of questionable worth because the observations on amount of moisture present are based on only a few visits to each stand. With the weakness of our evidence in mind, we report that the stands located in the *Carpinus* region of the ordination tended to have lower soil moisture. Stands 8 and 5 are recorded as "dry" and Stand 9 was recorded as "very dry". These are three of the four stands located in the primary *Carpinus* region. Stand 1, located in the far upper left corner of the ordination, had evidence of deep flooding by very rapidly moving water in the spring, but was nonetheless very dry during summer visits. Stand 11, located in the *Acer/Fraxinus* segment of the ordination, was a very wet cypress swamp, with some standing water all year. The remaining stands, despite the differences in their composition, were not obviously different from one another in soil moisture during our visits.

Discussion

Though our swamps tended to fall into three general types, there is a great deal of overlap in the distribution of species from the various groups. *Carpinus caroliniana* and *Liquidambar styraciflua* especially reach fairly high I.V. ($>$10) in stands basically dominated by *Acer* and *Fraxinus.* Oosting (1942) found *Liquidambar* to be less sensitive to environmental differences than *Fraxinus, Ulmus, Acer* and *Liriodendron,* and noted that it was adapted to a variety of conditions. Perhaps *Carpinus* is also widely tolerant, for it was recorded in all but two of our stands (14 and

17). In most stands the number of *Carpinus* recorded was only a small percentage of the number present, because most were too small ($< 4''$ dbh) to be included in our sample. In the stands where *Carpinus* was more important, it appears there were larger *Carpinus* trees rather than a great number of *Carpinus* individuals. Perhaps in those stands cutting occurred at such a time that *Carpinus* was "released" from growth inhibition due to shade, and has thus grown much faster under the open canopy. One of us (SW) has observed this occurrence in *Ilex opaca* in selectively cut upland forests of the area. The greater abundance of *Platanus occidentalis* and *Betula nigra* (both successional, shade intolerant species) in stands in which *Carpinus* is more important strengthens our interpretation that these stands may have been more open in the past, perhaps as a result of selective timbering. However, if our notion that *Carpinus* has increased in importance because of release through selective timbering is correct, then the relationship between *Carpinus* importance and drier sites discussed above, if valid, must not be a direct one.

It is generally agreed that *Taxodium distichum* is one of our most flood resistant species, and Bernard (1963) and Gemborys and Hodgkins (1971) regarded *Acer rubrum* as extremely moisture tolerant. Considering that *Quercus nigra* and *Quercus phellos* are both regarded as less flood tolerant than *Fraxinus americana* and *Acer rubrum* (Fowells 1965), one could interpret the ordination as representing a general moisture gradient from the left and lower *Quercus phellos*/ *Carpinus caroliniana* areas to the upper right *Acer*/ *Fraxinum*/*Taxodium* areas. Without quantitative measurement of soil moisture and depth, frequency, and duration of flooding, however, we are reluctant to make such a generalization. A desirable follow up of our study would be a season-long study of these moisture parameters in a group of bottoms with varying vegetational composition.

Penfound (1952) in describing southern swamps listed six shallow swamp communities. The community which appears most similar to the bottoms of this study is the *Acer*/*Liquidamber*/*Quercus* swamp. In that community, *Fraxinus pennsylvanica, Acer rubrum* and *Liquidambar styraciflua* are important, just as in our stands, but also important are *Quercus palustris, Platanus occidentalis* (both of low importance in our study), *Salix nigra* (we recorded one tree), and *Populus deltoides* (which we did not encounter at all). Further, Penfound (1952) described this community as transitional (successional). Similarly, Bernard (1963) described New Jersey bottoms having *Acer rubrum* as the most important dominant as successional. However, Monk (1966) concluded that the "mixed swamps" he sampled, dominated by *Acer rubrum, Nyssa sylvatica, Liquidambar styraciflua, Taxodium distichum* (plus two species we did not find, *Fraxinus caroliniana* and *Sabal palmetto)* are climax communities. While we did not examine quantitatively the smaller age classes in our study, we saw no evidence to suggest that a dramatic change of composition might occur in the future.

Our swamps seem to be more like those Florida swamps in this respect.

Perhaps as interesting as what we found in our bottom forests was what we did not find. Gemborys and Hodgkins (1971) and Monk (1966) found *Quercus nigra* to be important in Coastal Plain small stream bottoms, while it appeared in only three of our stands, and was structurally important in only one. *Magnolia virginiana* was found to be important by Gemborys and Hodgkins (1971), Monk (1966), and Bernard (1963), and it occurs in our area both in uplands and at the heads of small streams, but it was not present in any of our bottom forests. Seven other species which are sometimes structurally important in swamps of the North Carolina Coastal Plain (A. E. Radford, personal communication 1976) were also absent from our stands. Three of these *(Acer negundo, A. saccharinum, Populus deltoides)* are encountered in our area as planted shade trees on uplands, but apparently are not part of the native vegetation. Gemborys (1974) did not find the last two species to be important in Piedmont bottoms either, since his study site was also outside their natural range (Fowells, 1965), but he did find *Acer negundo* a leading dominant in one of his stands. Two other of the seven species, *Quercus laurifolia* and *Carya aquatica,* are very rare in our area. The last two species, *Populus heterophylla* and *Nyssa aquatica,* occur not infrequently in deep water swamps in our area, but were not in any of our sampled small stream bottoms.

Though there were numerous floristic and vegetational differences, *Acer rubrum, Fraxinus spp., Nyssa sylvatica, Liquidambar styraciflua, Magnolia virginiana,* and *Ulmus spp.* are the most consistently important species in the studies by Gemborys and Hodgkins (1971), Monk (1966), Gemborys (1974), Bernard (1963), and the present study. Of all trees ranking among the six most important non-conifer species in at least one of the study areas listed above, only *Sabal palmetto* (of Florida) and *Magnolia virginiana* were absent from the Virginia Coastal Plain swamps, and these plus *Platanus occidentalis* (of the Virginia Piedmont) were the only ones which did not assume major structural importance in at least one Virginia Coastal Plain stand. Thus, despite the board geographical area involved, there is remarkable structural similarity among the Alabama, Florida, Virginia Piedmont, Virginia Coastal Plain, and New Jersey small stream swamps.

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More Oribatid Mites in the Vicinity of Mountain Lake Biological Station, Virginia (Acariformes: Oribatida)

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Abstract—Sixteen additional oribatid mites, their collection sites and substrate, are reported from the vicinity of Mountain Lake biological Station, Virginia.

Introduction

A number of years ago I published a checklist of ninety-five species of oribatid mites found in the region of Mountain Lake, Virginia (Sengbusch 1957). The annotated list provided information on each collecting site and on the type of substrate in which the mites were found. At that time it was noted that the report should be considered preliminary.

Recently in re-examining approximately four hundred mounted microslides prepared during the above investigation, sixteen additional species of oribatid mites were discovered. Since the original paper contains the materials and methods, as well as a map of the collecting sites, there is no need to reproduce them here. In the intervening twenty years, however, there have been significant changes in the taxonomy of this group, so that the following list was classified according to Balogh (1972) and Krantz (1978).

Annotated List

(Arachnida: subcl. Acari: order Acariformes: suborder Oribatida)

Supercohort Macropylina (Oribatei Inferiores)
  Cohort Arthronotina
    Superfamily Parhypochthonoidea
      Family Parhypochthoniidae
        1. *Parhypochthonius graciliors* (Jacot) 1938. Leaf litter, Tawney's Cave entrance.
    Superfamily Northroidea
      Family Malaconothridae
        1. *Trimalaconothrus novus* (Sellnick) 1921. Wet moss, Old West Virginia Road.
      Supercohort Brachypylina (Oribatei Superiores)
  Cohort Apterogasterina (Gymnonota)
    Superfamily Hermannielloidea
      Family Hermanniellidae
        1. *Hermanniella picea* (C. L. Koch) 1840. Leaf litter, Tawney's Cave entrance.
    Superfamily Belboidea
      Family Belbodamaeidae
        1. *Porobelba parki* Jacot 1937. Leaf litter, Tawney's Cave entrance and exit.

      Family Damaeidae
        1. *Epidamaeus bakeri* (Hammer) 1952. Moss *(Hylocomium brevirostre)*, Little Stony Creek.
    Superfamily Eremuloidea
      Family Eremobelbidae
        1. *Eremobelba gracilior* Berlese, 1908. Moss, Little Stoney Creek; lichens on white oak; litter, Tawney's Cave entrance.
    Superfamily Eremaeoidea
      Family Eremaeidae
        1. *Eremaeus brevitarsus* (Ewing) 1917. Litter, Tawney's Cave exit.
        2. *E. hepaticus* C. L. Koch, 1836. Lichens on black oak; moss, Bald Knob.
        3. *E. translamellatus* Hammer, 1952. Wet moss, Cascades; lichens on red and black oaks; litter, Castle Rock.
    Superfamily Carabodoidea
      Family Carabodidae C. L. Koch, 1837
        1. *Carabodes labyrinthicus* (Michael) 1870. Moss, Bald Knob.
    Superfamily Otocepheoidea
      Family Suctobelbidae
        1. *Suctobelba acutidens* Forsslund, 1941. Moss, Bald Knob.
        2. *Suctobelba palustris* Forsslund, 1951. Litter, Castle Rock.
        3. *Suctobelba (Suctobelbella) frothinghami* (Jacot) 1937. Moss, Bald Knob.
        4. *Suctobelba (Suctobelbella) hurshi* (Jackot) 1937. Litter, Tawney's Cave exit.
        5. *Suctobelba (Suctobelbella) longicuspis* (Jacot) 1937. Moss, Bald Knob.
  Cohort Pterogasterina (Poronota)
    Superfamily Oribatuloidea
      Family Oribatulidae
        1. *Phauloppia lucorum* (C. L. Koch) 1741. moss, Cascades; lichens on white and black oaks.

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NOTES

VIRGINIA JOURNAL OF SCIENCE

OFFICIAL PUBLICATION OF THE VIRGINIA ACADEMY OF SCIENCE

DUE TO PROBLEMS BEYOND OUR CONTROL
PUBLICATION IS RUNNING VERY LATE.

THE VIRGINIA JOURNAL OF SCIENCE

Subscription rates for 1979: $15.00 per year, U.S.A.; $20.00 per year, other countries. All foreign remittances must be made at par U.S. dollars or their foreign equivalent. Back issues are available for $4.50 per issue postpaid.

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The original and two copies of each manuscript and of all figures therein are required. *Authors should submit names of three potential reviewers.* All articles should be typewritten, double-spaced throughout, on one side of good bond paper (8½ × 11 inches). Margins should be not less than 1¼ inches on any border. Each manuscript should be complete and final when submitted. It should include the title, author's name and affiliation, and proposed running title, all appearing on a title page, and a required abstract summarizing the text, particularly the results and conclusions, also appearing on a separate page.

The text should follow the general format used by professional journals in the author's discipline. Literature cited in the text should follow the name-and-year format: Fujishima and Honda (1972), or Spry (1969), or Guliday (1971). On the Literature Cited page at the end of the article each reference should include author(s), year, *title of article*, title of journal (using standard abbreviations), volume number, and first *and last* page of the article. For a book, include author(s), year title, pages or number of pages, and publisher and city of publication. Examples:

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Guilday, John E. 1971. Pleistocene History of the Appalachian Mammal Fauna. *In* Distributional History of the Southern Appalachians, Part III. Vertebrates (Perry C. Holt, ed.), pp. 223-262. VPI & SU, Blacksburg, Va.

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For illustrations, glossy prints are preferred to drawings. Each figure and table should be mentioned specifically in the text, with all figure numbers and legends typed consecutively on separate sheet, and the figures identified by author's name and figure number in pencil on the back. Table numbers and legends should be included as part of the table.

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VIRGINIA JOURNAL OF SCIENCE
OFFICIAL PUBLICATION OF THE VIRGINIA ACADEMY OF SCIENCE

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President's Report

It is an honor to present this report to the membership of the Virginia Academy of Science. Because so many members gave freely of their time and abilities to strengthen the Academy in its service to the scientific community of Virginia, serving as the 56th President of the Academy in 1978-79 provided many gratifying experiences.

During the course of a typical year, several invitations are received for the Academy to be represented at a variety of functions; the past year was no exception. Following is a list of such occasions in 1978-79:

On February 9-10, Drs. Ertle Thompson, Dennis W. Barnes, and Herbert McKennis, Jr. represented the Academy at the Conference on Environmental Law - Toxic Substances which was sponsored by the Marshall-Wythe School of Law, College of William and Mary.

On February 17, President Ulrich represented the Academy at the dedication of a lecture hall in memory of the late Wilbur T. Harnsberger, Jr., a fellow of the Academy and Chairman of the Local Arrangements Committee in 1975. Harnsberger Lecture Hall is located in the new physical science building at James Madison University.

On March 29-31, Dr. William J. Watts represented the Academy at the Governor's Conference on Libraries.

On April 7, Past-President Ralph A. Lowry represented the Academy at the inauguration of Dr. George W. Johnson as President of George Mason University.

Each year the Academy's Research Committee considers proposals for small grants to support scientific research by Academy members. These grants are made possible by an endowment which is specified for that purpose, and in recent years, members of the Academy have been invited annually to contribute to that endowment. Dr. Edgar S. Spencer, Chairman of the Research Committee, has reported that the following grants were awarded in 1978-79:

$300 to Dr. W. J. Matthews, Biology Department, Roanoke College

$150 to Dr. S. B. Ackerman, Biology Department, Old Dominion University.

$200 to Dr. Scott Geller, Psychology Department, Virginia Polytechnic Insitute and State University.

$491.81 to Dr. Carl Erkenbecker, Jr., Biology Department, Old Dominion University.

$353.50 to Dr. Dennis Darby, Geology Department, Old Dominion University.

Proposals for research grants in the range of $500 or less may be submitted to the 1979-80 Chairman of the Research Committee: Dr. Herbert McKennis, Jr., Department of Pharmacology, MCV-VCU, Box 726, Richmond, VA 23298.

The Annual Meeting is the highlight of each Academy year. The excellent and beautiful facilities of the University of Richmond with the thorough planning and efficient work of Mrs. Vera B. Remsburg, President-elect, and the Local Arrangements Committee (chaired by Dr. Frank Leftwich) combined to make the 1979 Annual Meeting a truly outstanding one. Included on the program were 446 scientific papers and a full Virginia Junior Academy of Science program. Encouraging brilliant young people in their pursuits of scientific work is a vital contribution to future generations which the Academy is continually making, and the Annual Meeting plays an essential role in that effort.

Each year, the J. Shelton Horsley Award is made for the outstanding paper presented at the Annual Meeting. This year a committee of members of the Virginia Academy of Science selected Dr. W. L. Dewey of the Department of Pharmacology, Medical College of Virginia, as the 1979 recipient of this coveted award for his paper entitled "Evidence for the Release of Enkephalins and Other endogenous Opiates by Morphine."

At the conclusion of the 1978 Annual Meeting, Council recommended that the annual Sidney S. Negus Memorial Lecture take the form of a symposium in 1979. With the assistance of Dr. Arthur W. Burke and Miss Virginia C. Ellett, Co-Chairman of the Committee on Scientific Education, and Dr. Ertle Thompson, Chairman of the Committee to Plan a Science Advisory System, the President arranged for the Sidney S. Negus Memorial Symposium on the topic "The Commonwealth-Science Education and Technology." Panel participants were the Honorable Maurice B. Rowe, Secretary of Commerce and Resources; Dr. W. E. Campbell, Superintendent of Public Instruction; Dr. Frank L. Hereford, Jr., President, University of Virginia; and Dr. Helmut Wakeham, Vice-President for Science and Technology, Philip Morris, Inc. Their papers will be printed in a later issue of the Virginia Journal of Science.

VAS Council meets each fall and late winter in addition to two meetings during the Annual Meeting. It is through its committee structure that the Academy deals with problems that arise, responds to opportunities, and plans its future. The annual reports by the committee chairmen which are printed below highlight an increase in membership in 1978-79, budgetary concerns, and numerous programs. One of the major problems facing the academy in this inflationary period is the task of publishing the Virginia Journal of Science within a budget which the Academy can afford. The Academy is fortunate that the new Editor, Dr. Stewart A. Ware, and the new Business Manager, Mr. Franklin D. Kizer, are committed to doing everything possible to achieve that goal.

In conclusion, it is a pleasure to report that the Virginia Academy of Science is a healthy, vigorous organization which is responding to its concerns in a thoughtful, organized manner with the clear goal of serving better the interests of the scientific community and the common good in Virginia.

Respectfully submitted,
Dale V. Ulrich
President, 1978-79

Virginia Academy of Science
Fifty-Seventh Annual Meeting, University of Richmond
May 8-11, 1979

Visiting Scientists Program

In April, 1978, permission was obtained from Dr. W. E. Campbell, Superintendent of Public Instruction, State Department of Education, to conduct the visiting Scientists Program in the public schools of the Commonwealth during the 1978-79 academic year. Notice of this permission was conveyed to each Division Superintendent from the State Superintendent's Office in Supts. Memo. No. 97, May 5, 1978.

Also, in May commitments were obtained from the Presidents of thirty-two colleges and universities in Virginia to pay the travel expenses of their faculty members who would be invited to give lectures under the Visiting Scientists Program. Multiple copies of the 1978-79 Visiting Scientists Program were distributed to each high school in Virginia in September.

In January, 1979, each speaker listed in the 1978-79 Visiting Scientists Program was sent a copy of the Program and a letter thanking them for their participation. Also, the 377 speakers who were not members of the academy were each sent an invitation to join the Academy, an Academy brochure, and a membership application.

The 1978-79 Visiting Scientists Program has been very successful with 617 participating scientists and educators offering 972 topics to Virginia high schools and science clubs. Reports of visits received from the schools this year indicate that 3716 students have enjoyed lectures and demonstrations by visiting scientists. This represents an 18.6% increase over last year. Several high schools have used the Visiting Scientists Program in their programs for gifted students and many find letters of appreciation have been received.

Working with the Visiting Scientists Program has been a rewarding experience. Recently, other responsibilities made it necessary for me to discontinue serving the Academy as the Director of the program. Dr. Harold M. Bell of the Chemistry Department at Virginia Polytechnic Institute and State University is the new Director of the Visiting Scientists Program. I am certain that each member of the Academy joins me in strongly supporting Dr. Bell in his newest service to the Academy.

Gerald R. Taylor, Past President

The Awards Committee

The Committee reviewed nominations and recommended the Council election as Fellows of the Virginia Academy of Science: S. Gaylen Bradley, professor and Chairman, Department of Microbiology, Virginia Commonwealth University and Secretary of the Academy, 1976-1978; Addison D. Campbell, Professor of Physics, University of Richmond; William M. Hinton, Professor Emeritus of Psychology, Washington and Lee University and President of the Academy, 1959-1960; William L. Mengebier, professor and Chairman, Biology Department, Bridgewater College; Maurice B. Rowe, Secretary of Commerce and Resources, Commonwealth of Virginia and President of the Academy, 1970-71; Jackson J. Taylor, Chairman of the Department of Physics, University of Richmond, and President of the Academy, 1962-1963; Ertle Thompson, New School of Education, University of Virginia.

The Committee proposed and recommended to Council, election as an Honorary Life Member in the Virginia Academy of Science, Edward S. Harlow, retired Vice President of the American Tobacco Company and President of the Academy, 1956-1967, in recognition of his long service and devotion to the Academy. Dr. Edward F. Turner, Jr., Professor of Physics and Department Head, Washington and Lee University, until his untimely death September 30, 1978 was selected for posthumous presentation of the Ivey F. Lewis Distinguished Service Award for 1979 for his love of the Academy and for his continued and extraordinary support of it. He was President, 1971-72.

Members were urged to submit nominations for Fellows to the Executive-Secretary of the Academy before the June 1 deadline and to send suggestions for the Ivey F. Lewis Distinguished Service Award and for Honorary Life Members to the Awards Committee.

Lynn D. Abbot, Jr., Chairman

The Finance and Endowment Committee

From the Summary of Receipts and Disbursements for 1973-1978 (Table 1), the following highlights may be noted regarding our most recent fiscal year ended 31 December:

1. Gift income is the highest in the five year period. This is due to increased corporate giving, most of which was solicited by the Jr. Academy.
2. Annual meeting receipts increased because of the larger number of exhibitors recruited for the Blacksburg meeting and because of a slight increase in registration fees.
3. Total receipts were up 27% over the average of the previous four years.
4. Journal expense of $18,088 is 72% over the aver-

age of the previous four years reflecting increased paper and printing costs as well as a somewhat erratic publication schedule. These costs constitute our greatest area of concern in Academy finances at present.

5. The General Fund balance of $42,749 remains well within the guidelines set by Council of one year's operating expense. 1978 was the first deficit year since the deficits of 1968, 1970, and 1972.

6. The 1979 deficit is projected to be $8675 on projected expenditures of $46,275. Journal costs for 1979 are projected to be 45% of total expenses whereas the average for the last decade has been 37%. This highlights further the somewhat increased priority which our publication has taken in the total Academy program.

7. Membership of 1466 at the end of 1978 is up about 100 members, reversing a trend of decreases since 1969 when year end membership was 1707, the all time high for the Academy.

You, the members, remain the key to a successful Academy. By your support in giving papers, recruiting new members and serving on committees, you make the VAS what it is. Your comments and suggestions are welcomed. Please let us know what you think should be our priorities in expending Academy funds.

D. Rae Carpenter, Jr., Chairman

The Fund Raising Committee

The Committee continued its program of giving the membership the opportunity to contribute the support of research by providing a space on the annual dues statement for such a contribution. Several individual, corporate, and foundation prospects were visited by committee members during the year to solicit contributions to the Acadmey. No grants have been received as yet.

J. Samuel Gillespie, Jr., Chairman

Membership Committee Report

I should like to take this opportunity to thank all members of the Membership Committee who have worked cooperatively during this academy year. They have supplied ideas and have carried out whatever services they were asked to perform.

Recognition should also be made to Dr. Gerald R. Taylor who in his contact with the Visiting Scientist Program distributed membership application blanks and brochures of the Academy to all prospective speakers. Special thanks also go to Dr. Dale Ulrich who in his contact with scientists of the state made continued efforts to secure memberships. Other members of the Academy who have demonstrated interest were called upon to contact prospective members.

Dr. Harold M. Bell of the Chemistry Dept. of V.P.I. & S.U. is the new Director of the V.A.S. Visiting

Scientist Program and is being asked to continue the practice of including application information concerning the academy in his mailings to the potential speakers in the program.

The following will give a more complete picture of the contacts that were made:

1. Persons whose names were on the 1978 program of papers who were not members of the Academy.
2. Persons who had allowed membership to lapse.
3. Section chairmen were requested to contact non-members within their disciplines.
4. All persons on Visiting Scientists Program were sent application blanks and brochures.
5. Persons whose names appeared in the Visiting Scientist Program who were not members of the Academy were contacted a second time.
6. Brochures and membership applications were distributed to an additional number of people through contact by mail and through distribution at the Virginia Science Teachers Meeting.

The results of these efforts have been favorable. The membership has increased during 1978 by 106 new members (Table II). A good deal of effort went into the years activities but because of the favorable results the same type of effort will be exerted during the next year.

Warwick R. West, Jr., Chairman

Publications Committee

During the year, a questionnaire survey regarding the Virginia Journal of Science was distributed to the membership. As reported in the President's Newsletter of November 15, 1978, the response was quite good (about 37% of the membership), and the members favor continuation of the Journal (35% of the responders).

Dr. Kuldip Chopra resigned as Editor of the Journal in May, with the intention of completing Volume 29 (1978). Owing to a combination of circumstances, publication of the remaining issues has fallen behind schedule by a considerable amount, and efforts are being taken to restore the schedule as soon as feasible.

Dr. Stewart Ware, Chairman of the Biology Department at College of William and Mary, has accepted an appointment as Editor effective with Volume 30 (1979). Dr. Ware expects to make a concerted effort to expedite a consistent publication schedule. To do so, he will need the full cooperation of the membership in the submission of materials for publication, and the Publications Committee urges each of you to participate in the continuing success of the Journal as contributors.

An active Business Manager, Frank Kizer, has assumed office. In collaboration with the Editor, the Publications Committee, Council, and the membership, a renewed effort to solicit advertising and to review publication costs has been initiated and will be a continuing concern of the Committee.

John H. Wise, Chairman

Table I. Summary of Receipts and Disbursements - 1973-1978

	1973	1974	1975	1976	1977	1978
RECEIPTS						
Dues	$16,913	$19,631	$18,721	$18,290	$16,352	$16,950
Gifts	2,276	2,120	2,505	2,130	2,977	5,417
Annual Meeting	5,497	4,040	5,323	5,794	5,278	9,164
Virginia Journal	4,312	5,168	2,013	1,966	2,568	4,014
Interest	1,425	1,618	1,780	2,130	2,223	1,802
Inc. from Trust Fund	—	2,039	2,000	2,000	3,000	2,200
Other	635	500	676	606	455	674
From Savings & Others	—	—	—	—	—	1,693
	$31,058	$35,116	$33,018	$32,916	$32,853	$41,914
DISBURSEMENTS						
Salaries & Benefits	1,914	2,613	2,117	2,475	2,821	3,105
General Expense	3,027	3,431	3,254	2,879	2,722	—
Meeting Expense	2,575	1,337	2,510	3,248	2,180	3,156
Sponsored Prorams-Jrs.	8,875	8,706	10,360	9,349	10,880	10,802
Va. Journal	12,905	14,401	9,079	10,165	6,049	18,088
Committees*	1,000	3,252	2,386	1,825	2,733	3,391
Transf. to Savings						
& Others	762	1,376	3,313	2,975	4,468	—
	$31,058	$35,116	$33,018	$32,916	$32,853	$41,914
General Fund Assets						
31 December	$34,887	$35,144	$38,455	$41,851	$44,442	$42,749
Research Fund						
Disbursements		$ 2,860	$ 2,000	$ 1,525	$ 2,000	$ 2,429
$ 2,964	incl. above	incl. above	incl. above	incl. above	incl. above	incl. above

*Principally Research & Flora

Table II. Membership Statistics 1973-1978

Membership Begin. year	1,604	1,563	1,542	1,506	1,426	1,360
Add	156	237	176	111	93	224
Resign & Died	-71	-86	-62	-68	-57	-26
Dropped-Non Pay.	-126	-172	-150	-123	-102	-92
End of Year	1,563	1,542	1,506	1,426	1,360	1,466
Regular	1,280	1,276	1,233	1,172	1,113	1,165
Contributing	137	113	110	106	100	100
Sustaining	46	43	46	45	46	53
Student	63	73	78	61	63	113
Life	13	13	13	18	17	16
Business	24	24	26	24	21	19

The Trust Committee

The trust funds of the Academy of Science have been under the administration and guidance of First & Merchants in accordance with Council's directive in 1976 to have the funds administered by a trustee. The agreement was dated November 23, 1976, and the status of the trust as of February 21, 1979, was as follows:

Estimated 1979 cash income from the trust	$ 3,380,000
Principal cash on hand as temporary investment	662.00
Asset carrying value	50,140.33
Market value	45,658.00

The market to book carrying value is .91 to 1, and the return on the investment (carrying value) annualized is 6.7%. The performance of this account appears to be in line with the performance of the market in general, and hopefully the remainder of 1979 will be a better one for the trust than 1978.

The Trust Committee agreed with the recommendation of Rae Carpenter that as the Virginia Academy of Science accumulates income a portion of it should be used to purchase additional units of the Academy Trust Fund. This was in accordance with the recommendation of the senior trust officer and resulted from the Executive Secretary-Treasurer depositing $662

into the trust fund in January, 1979, while still having approximately $1,000 of accumulated income in the trust that could be used to purchase additional trust units. The Trust Committee concurred with the recommendation, and the Chairman of the Finance and Endowment Committee and the Executive Secretary-Treasurer were informed that it would be appropriate to take the $1,000 of accumulated income to purchase additional units in the trust fund.

The Trust Committee believes that the present arrangement with First & Merchants should be continued, and the Trust Committee will continue to monitor the First & Merchants performance and follow the directives of the Council.

Stanley Ragone, Chairman

Ad Hoc Committee on Business Relations

Attempts have been made to encourage additional companies to become business members of the Academy. Emphasis has been placed on companies which have shown interest in the Academy in some way but had not become business members. On the basis of this approach, Allied Chemical has been added to our list of business members. It is hoped that additional companies can be enlisted in this way.

In a meeting of the Business Relations Committee some time ago the suggestion was made to have a symposium at the annual meeting on a subject which would appeal to the industrial scientists. The Chemistry Section, in cooperation with the Business Relations Committee, has planned such a symposium for this 1979 annual meeting. The subject of the Symposium is "Recent Trends in Chemical Research in Industry". The Symposium is scheduled for 1:10 p.m. Thursday, May 10, in the University of Richmond Science Center Auditorium.

W. Allen Powell, Chairman

Ad Hoc Committee to Plan a Science Advisory System

Activities of the Ad Hoc Committee to plan a Science Advisory System during the past year included the following:

1. Review and recommendations relative to the final report of the study of State Science, Engineering and Technology Capacity in Virginia State Government, in cooperation with the Commonwealth of Virginia Department of Intergovernmental Affairs, with support from the National Science Foundation.

   As required by terms of the National Science Foundation grant, one element of the overall SSET work plan was to develop an inventory of science, engineering and technology resources available to advise state government on problems with a scientific content. To accomplish this task, a semistructured survey instrument was mailed to the entire membership of the Virginia Academy of Science on October 26, 1978.

This survey (forms appended) was designed to identify pesons by scientific specialty who would be willing to serve in an advisory and/or consultative capacity to state government. In addition, the survey attempted to identify the general terms of availability, as noted below:

   a. number of days at no reimbursement
   b. number of days at expense reimbursement only
   c. number of days for consultant fee plus expense reimbursement.

Survey Results

Two hundred five (205) members of the Virginia Academy of Science responded to the survey, indicating both an interest and a willingness to participate in the science advisory system, as their expertise is needed. This represents an impressive base of expertise upon which to build a science advisory system.

A cross-referenced index of individuals and areas of scientific interest and expertise has been compiled by the Chairman of the Ad Hoc Committee on Science Advisory.

The final report and recommendations were made to the Department of Planning and Budget, with a letter of support (copy appended) from the Chairman of the Ad Hoc Advisory Committee on February 22, 1979. A major recommendation was that the Ad Hoc Committee to Plan a Science Advisory System of the Virginia Academy of Science should continue to serve as the Executive Branch's major link to the scientific community as the recommendations are implemented. The Ad Hoc Committee and the Science and Technology Assessment Officer in the Department of Planning and Budget should jointly explore ways to broaden the participation on the Advisory Committee to include other elements of the scientific community, particularly with respect to the social sciences and from the private research-oriented industries.

To date, no action has been taken by Executive Branch relative to the implementation plan as recommended in the report. Therefore, action on the final format of a Science Advisory standing committee within the Academy has been postponed pending response to the SSET Study report.

2. The Chairman of the Ad Hoc Committee on Science Advisory, along with E. L. (Chick) Wisman, represented the Academy at the Association of State Academies in conjunction with the AAAS meeting in Houston, Texas, January 3-8, 1979.

3. Three members of the Ad Hoc Committee, Dennis W. Barnes, Herbert McKennis, and Ertle Thompson, participated in the Conference on Environmental Law—Toxic Substances, at the College of William and Mary, February 9-10, 1979. This conference was one of the first funded

by the Virginia Environmental Endowment created by the voluntary contribution of $8 million in 1977 by Allied Chemical Corporation following the pollution of the James River with Kepone.

4. A test of the proposed advisory mechanism came before executives in government had time to review the proposed plan. The Chairman of the Executive Branch Task Force to study the feasibility of a Virginia Resource Information System requested consultation and advice in the area of physical and natural resources information systems. Using the personnel resource information file compiled to date, supplied to the chairman of the VARIS task force. Ten people were invited to participate in an advisory role in the work of the task force, eight of whom responded favorably. The first working meeting was held at the University of Virginia on March 29, 1979. The work will continue through the summer with the final report to be presented to the General Assembly by December 1, 1979.

Submitted for the Committee: Paul B. Siegel, Maurice B. Rowe, Bernard R. Woodson, Arthur W. Burke, Jr., Dennis W. Barnes, and Herbert McKennis.

Ertle Thompson, Chairman

Ad Hoc Committee on Science Education

The Academy's ad hoc Committee on Science Education cooperated with the Virginia State Department of Education in planning and sponsoring the annual fall State Science Teachers Conference. The 1978 meeting was held at the Hotel Roanoke, Roanoke, Virginia, and was attended by about 400 supervisors and science teachers from middle and senior high schools across the State. The Virginia Association of Science Teachers (VAST) also co-sponsored this meeting.

The ad hoc Committee on Science Education arranged, through the University of Virginia, School of Education, to offer a special course in Meteorology-Earth Science, which twenty-three teachers completed for one graduate credit in Earth Science. This special course was taught by Drs. Joanne and Robert Simpson, School of Environmental Sciences, University of Virginia, with the assistance of Dr. R. Wesley Batton, Mrs. Ida Beaton, and Mr. P. K. Black of Richmond, Virginia.

The credit course was well received by the teachers and, Dr. Joseph Exline, Associate Director of Science for the State Department of Education, expressed gratitude that it helped provide accreditation in an area of science that is not very accessible to school teachers.

The 1979 fall conference will bring together science supervisors and teachers from all of the levels of public instruction (K-12) for the first time. Plans are well underway to provide a good meeting with a central theme, "The Past, The Present and The Future of Life". Conferences and workshops will be offered which will focus on timely information that will be useful to the school teachers in daily classroom instruction. The 1979 meeting is scheduled for October 5th and 6th at the Cavalier Hotel, Virginia Beach, Virginia.

Virginia C. Ellett and
Arthur W. Burke, Jr., Co-Chairmen

Abstracts of Papers
Agricultural Sciences

Fifty-seventh Annual Meeting of the Virginia Academy of Science
May 8-11, 1979, University of Richmond

PLASMA PROGESTERONE IN DAIRY HEIFERS NEAR PUBERTY. G.W. Anderson*, R.F. Krall*, F.C. Gwazdauskas, D.L. Aalseth* and J.A. Lineweaver. Dept. of Dairy Sci. Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Five Holstein heifers about 12 months of age at the Dairy Cattle Center were used in a study to determine peripheral plasma progesterone concentrations in the peripubertal period. Estrus was not visually detected prior to the study. Heifers were fitted with indwelling polyvinyl jugular catheters and bled (10 ml) daily for 31 days at approximately 1700 hours. Subsequent estrus activity was monitored by use of KaMar heat mount detectors and visual observation. Following blood collection, plasma was harvested after centrifugation and frozen at -20C until progesterone was quantified by radioimmunoassay (RIA) techniques. To validate the progesterone assay .5, 1, 2 and 5 ng of progesterone were added to .5 ml plasma. Following organic solvent extraction and RIA .56, .97, 1.77 and 6.69 ng were recovered, respectively. Plasma progesterone was $8.04 \pm .45$ ($\bar{x} \pm$ SEM) ng/ml for the entire study. Progesterone was .22 ng/ml in one heifer on the day of observed estrus. Heifers were inseminated between 2 and 3 months following the last bleeding. All were diagnosed pregnant with 1.4 services per conception. It appears that the corpus luteum of peripubertal heifers is active.

SOYBEAN MILL RUN IN STARTER DIETS FOR WEANED PIGS HOUSED IN TRIPLE-DECK CAGES. S. R. Arthur*, C. L. Gaines*, K. L. Bryant and E. T. Kornegay. Dept. of Animal Science, Va. Polytechnic Inst., Blacksburg, Va. 24061

Two trials using 66 crossbred pigs averaging 10 lb (five per cage in trial 1 and six per cage in trial 2) were conducted to compare zero and 10% soybean mill run in starter diets. Pigs were housed in an environmentally controlled triple-deck nursery containing six 3 x 4 ft cages (two stacks of three cages each). Pigs were randomly assigned from outcome groups based on sex and weight to treatments. Both diets were fed on each deck. A 22% crude protein corn-soybean meal diet with 10% dried whole whey was fed until the average pen weight reached 15 lb; then a 20% diet to 25 lb; and an 18% crude protein corn-soybean meal diet without whey to the end of the trial. Pigs were on test seven weeks in trial 1 and six weeks in trial 2. Overall average daily gain, feed intake and feed per gain were not different for pigs fed the starter diets with or without soybean mill run. There were no differences (P>.10) between pigs housed on the three levels for average daily gain, feed intake and feed per gain. Pigs initially dunged in the rear of the cage and were clean at all levels; however, toward the end of the trial, pigs on the bottom decks were not as clean which probably resulted from dunging over a larger part of the cage due to crowding. The addition of 10% soybean hulls did not improve the performance of weaned pigs.

ECONOMIC DECISION MAKING IN PEST AND DISEASE MANAGEMENT USING VARIOUS GAMES THEORY MODELS. Kenneth H. Baum* and Ronald W. Tillman, Dept. of Agricultural Economics, and Dept. of Plant Pathology and Physiology, Va. Polytechnic Inst. and St. Univ., Blacksburg, VA 24061.

Producers of agricultural commodities must make pest and disease management decisions affecting the profitability of their enterprise in a stochastic and uncertain environment. The time lags between the start and end of the production period, or the recognition and treatment of the many pest and disease problems facing producers also complicates management decision choice of economically optimal control strategies. In this paper, the authors suggest these management decision problems can be viewed as games farmers play against "nature" to maximize their net income. Consequently, five game theory models are examined and compared as theories for making pest management choices in the control of apple scab (Venturia inaequalis) in an orchard. These models include (1) Wald's maximin criterion, (2) Laplace's principle of "insufficient reason", (3) Hurwicz's "optimism-oessimism" criterion, (4) Savage's "regret" criterion, and (5) the Heady and Agrawal "benefit" criterion.

INBREEDING VERSUS SELECTION IN BEEF CATTLE AT THE FRONT ROYAL STATION. III. WEANING TRAITS BY GENERATION, 1950-69. K. P. Bovard and W. T. Butts, Jr.*, Dept. of Animal Science, VPI & SU, Blacksburg, Va. 24061 and USDA, Knoxville, Tn. 37916

Five preweaning traits, namely birth weight, fall weight, fall ADG (lb/day), weaning type score and pre-test ADG, were studied. Two additional quasi-independent variables, inbreeding of calf, Fc, and inbreeding of dam, Fd, were treated as dependents for certain analyses. Data came from 3663 calves born 1950 through 1969 at the Beef Cattle Research Station, Front Royal, VA. That study was designed to compare two mating systems, intense inbreeding and mass selection, in Angus, Hereford and Shorthorns. Separate least squares (L.S.) analyses were made for each sex-breed class using a model that fit for year of birth, calf age in days, and calf generation within line and mating system. From the 30 L.S. analyses of the five traits first named above, R-squared values ranged from .13 to .59. In contrast, R-squared values for inbreeding of calf and of dam ranged from .36 to .87. In Angus bull calves, for example, changes in fall weight ranged from -1.15 to -23.10 lb/generation among inbreds; values were 3.03 and 15.84 in type and growth selection lines, resp; changes in Fc ranged from 9.3 to 15.7% per generation among inbreds; values were -.2 and .7% in type and growth selection lines, resp. Results were similar for comparable sex-mating system classes.

INBREEDING VERSUS SELECTION IN BEEF CATTLE AT THE FRONT ROYAL STATION. IV. POSTWEANING TRAITS BY GENERATION, 1950-69. K. P. Bovard and W. T. Butts, Jr.*, Dept. Animal Science, VPI & SU, Blacksburg, Va. 24061 and USDA, Knoxville, Tn 37916

Three postweaning traits, namely pre-test ADG (lb/day), test ADG, and yearling type score were studied. Two additional quasi-independent variables, inbreeding of calf, Fc, and inbreeding of dam, Fd, were treated as dependents for certain analyses. Data came from 2611 calves born 1950 through 1969 at the Beef Cattle Research Station, Front Royal, VA. That study was designed to compare two mating systems, intense inbreeding and mass selection, in three breeds. Separate least squares analyses were made for each sex-breed class using a model that fit for age of dam, calf age in days, and calf generation within line and mating systems. Numbers of bull, heifer and steer calves in Angus were 224, 589 and 129, resp.; in Herefords were 154, 500 and 85, resp., and, in Shorthorns were 228, 553 and 149, resp. From the 27 L.S. analyses of the first three traits cited above, R-squared values ranged from .06 to .44. In contrast, R-squared values for Fc and Fd ranged from .26 to .87. In Angus bull calves, for example, changes in test ADG ranged from .01 to .14 per generation among inbreds; they were .12 and .19 for type and growth selection lines, resp. Other results were similar for comparable sex-mating system classes.

SUPPLEMENTAL BIOTIN FOR SWINE. I. PERFORMANCE, HAIR AND STRUCTURAL SOUNDNESS SCORES FOR DEVELOPING GILTS. K. L. Bryant, J. W. Knight and E. T. Kornegay. Dept. of Animal Science, Va. Polytechnic Inst., Blacksburg, Va. 24061

Two 20-week feeding trials using 160 gilts were conducted to evaluate the performance of developing gilts fed two levels (0 and 220 µg/kg diet) of supplemental biotin. The gilts averaged 30 days of age and 6.8 kg of weight when placed on trial. A corn-soybean meal basal diet fortified with minerals and vitamins was self-fed. Protein, calcium and phosphorus levels were adjusted according to recent NRC requirements for both levels of biotin as the gilts grew. Gilts were housed in pens with either partial or total slotted floors. The combined data for both trials revealed no difference (P>.10) in performance between gilts receiving 0 and 220 µg of supplemental biotin per kg diet. The following performance data were obtained: average daily gain, .57 and .58 kg; average daily feed, 1.59 and 1.59 kg; feed per gain, 2.79 and 2.74, respectively for 0 and 220 µg per kg of supplemental biotin. Subjective hair and structural soundness scores were not different between gilts fed diets with and without supplemental biotin.

INFLUENCE OF RESTRICTED GROWTH RATE AND ELEVATED LEVELS OF MINERALS AND VITAMINS ON FEET AND LEG CHARACTERISTICS, SOUNDNESS SCORES AND FEEDLOT PERFORMANCE IN DEVELOPING GILTS D. F. Calabotta[1], G. A. Kesel[2], H. R. Thomas, J. W. Knight, H. P. Veit, D. R. Notter[#] and E. T. Kornegay. TRCEC, Dept. of Animal Science and Dept. of Veterinary Science, VPI & SU, Suffolk, VA 23437 and Blacksburg, VA 24061

Weaned crossbred gilts (96-six reps of 4/pen/treatment) were used in a 2 x 2 factorial experiment to compare the following treatments: 1) Ad lib intake-NRC daily minerals and vitamins (NRC-MV); 2) 75% ad lib-NRC-MV; 3) Ad lib-150% of NRC-MV; 4) 75% of ad lib-150% of NRC-MV. Feet and leg measurements were taken and lesions, if observed, were characterized at 37, 119 and 185 days of age (7.3, 48.9 and 92.5 kg). As expected, restricted fed pigs consumed less and gained less. Mineral and vitamin levels had little effect on performance, although pigs fed the high mineral and vitamin levels were slightly more efficienct (P < .05) overall. Percent born was lower (P < .05) at 119 days of age for the front inside tow and at 185 days of age for the front outside toe for pigs fed the high vs NRC level of minerals and vitamins. The volume of the inside front toe at 119 days of age was greater (P < .05) for the ad libitum vs restricted fed pigs. Similar results were observed at 119 days and 185 days for the hind inside toe volume. There were no differences in average front foot score and average hind foot scores for restricted vs ad libitum fed pigs, however, pigs fed the higher vs NRC mineral and vitamin levels had better (P< .05) front foot scores.

DIPEPTIDE, AROMATIC AMINO ACID, AND HEMOPROTEIN LEVELS IN BLOOD PLASMA OF FEEDER STEERS AND DAIRY COWS. G. Colmano, T. E. Lesch[‡] C. E. Polan[‡] K. E. Webb[‡] Depts. of Vet. Sci., Dairy Sci., and Animal Sci., VPI & SU, Blacksburg, VA 24061

Steer calves were divided in 4 groups of protein supplementation: 1. urea-choline, 2. soybean meal, 3. urea, and 4. soybean meal-choline. Lactating cows were divided in 2 groups: 1. less than 80 days lactation, and 2. more than 80 days lactation, with each group having 2 levels of crude protein and 2 levels of crude fiber. The traditional methods used to determine the nutritional utilization of protein and animal performance were compared to spectrophotometric determinations of blood plasma. The absorption spectra of blood plasma revealed three major peaks respectively associated with dipeptide bonds of protein in the 180-220 nm region, with aromatic amino acid residues at 280 nm, and with porphin derivatives from hemoproteins at 414 nm. While the traditional records of average daily gain, total protein, and blood urea nitrogen did not correlate well with the different levels of protein supplementation so far tested, the spectrophotometrically determined peaks in blood plasma followed the utilization of protein supplement fed to the animal, indicating that the higher protein supplementation was followed by a higher protein utilization by the animal. Preliminary studies with a far ultraviolet spectrophotometer indicated increased distinction of characteristic shifts in protein composition, and may allow the study of efficiency of bypassed-protein and microbial protein synthesis.

MOVEMENT AND DISAPPEARANCE OF CAPTAN[©] AND DIFOLATAN[©] IN WOODSTOWN LOAMY SAND SOIL. C. W. Conner, R. J. Stipes, R. W. Tillman, and D. F. Amos. Depts. of Plant Pathol.-Physiol. and Agronomy, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061.

The movement and disappearance of captan (Captan[©] 50 W) and captafol (Difolatan[©] 50 W) in a raw, Virginia peanut soil was studied. Vertical movement was monitored by soil column leaching, and disappearance by incubating fungicide-amended soil. Residues were removed from treated soil by solvent extraction, and detected by paper-disk assays on agar plates surface-seeded with Glomerella cingulata. When leached with H₂0, both compounds moved into the 10 to 15 cm soil depth, with traces of captan detected in the 15 to 20 cm depth. Movement in all cases was greatly enhanced by leaching with 10% Tween 80. Both compounds disappeared in less than 2 weeks when blended into soil at label rates. At higher application rates, however, the disappearance of captafol was much slower than that of captan. At twenty times the label rate and at 21 C incubation, captan (120 µg/g) disappeared in less than 24 weeks, while captafol at twenty times the label rate (80 µg/g) showed activity after 48 weeks at the termination of the study.

EFFECTS OF PROGESTERONE/ESTRONE SUPPLEMENTATION ON CONCEPTUS DEVELOPMENT AND LITTER SIZE IN SWINE. D. Lee Dalton, James W. Knight and C. R. Underwood, III. Dept. of Anim. Sci., VPI&SU, Blacksburg, Va. 24061

Following hysterectomy at day 50 of gestation, it was found that gilts which had received exogenous progesterone (P) and estrone (E) between 20 and 30 days of gestation (P/E 20-30) had placentas which were significantly (P <.01) longer and heavier than gilts which received P/E from days 4 to 20 of gestation (P/E 4-20) or control gilts which received corn oil (CO) from days 4 to 30 of gestation (CO 4-30). Placentas from P/E 4-20 gilts tended to be heavier than those from controls. Allantoic fluid volume was also greater in those gilts receiving exogenous P/E. These data suggest that exogenous P/E during the first 30 days of gestation had a stimulatory effect on placental development. At day 50, no differences were found in fetal crown-rump length, but fetal weight was greater in the P/E 20-30 gilts. There were no differences in number of live pigs, percent survival, empty uterine weight, uterine length or amniotic fluid volume. Uterine surface area was less (P < .05) in the CO 4-30 gilts than in the two P/E groups. Data obtained from 33 gilts similarly treated during early gestation and allowed to farrow revealed no treatment differences for any reproductive performance trait measured at farrowing.

CHANGES IN THE LIPID COMPOSITION OF CONTINUOUSLY CULTURED CHLORELLA VULGARIS INDUCED BY THE PLANT GROWTH RETARDANT CYCOCEL. G. A. Davis* and D. M. Orcutt. Department of Plant Pathology and Physiology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

For many plants, Cycocel (2-choroethyl) trimethylammonium chloride has been shown to increase tolerance to environmental stress. Tolerance to freezing temperatures, high salinity, and drought conditions may be a result of changes in membrane lipid composition. Chlorella vulgaris was maintained in continuous culture at a constant cell density. The effect of Cycocel at 1x10-6M on the lipid composition of the cells in a steady state condition was determined by gas-liquid chromatography. Treatment resulted in increases in concentrations of phospholipids, triglycerides,free fatty acids, and hydrocarbons. Increases in the total amount of saturated and unsaturated fatty acids occurred with Cycocel treatment. However, a shift in the relative amounts of linolenic acid (18:3), the predominant fatty acid of the control tissue,to linoleic acid (18:2) which predominated in treated tissue, was observed in the phospholipid and free fatty acid classes. Free sterol concentrations were reduced by the treatment.

PARASITISM OF THE THISTLE HEAD WEEVIL, RHINOCYLLUS CONICUS, IN NEWLY-ESTABLISHED AND WELL-ESTABLISHED SITES. P. F. Dowd and L. T. Kok. Dept. of Entomology, VPI & SU, Blacksburg, Va. 24061

Rhinocyllus conicus (Froelich) is an imported biological control agent of Carduus thistles which has been released in Virginia over a 10-year period. Several native parasites have been found parasitizing this introduced weevil. This study compares the rate of parasitization of R. conicus in newly established and well established release sites.

Terminal flower heads (100) of Carduus nutans (musk thistle) were collected in late June from each of three release sites, representing recent (3-5 yr), intermediate (6-8 yr) and well established (> 8 yr) weevil populations. Twenty heads per site were dissected soon after collection, and the remaining heads were divided into 4 groups of 20 heads each. Each group was placed in a cloth bag and observed for parasite emergence. All heads were dissected after parasite emergence ceased. Mean rate of parasitization of R. conicus larvae in the intermediate site (5.00+1.78%) was found to be significantly greater (P<0.05) than that of the well established site (.28+.55%) as well as the recently established site (1.2+1.33%). The latter two sites were not significantly different from each other. The results do not indicate any sustained increase in parasitization of R. conicus by the native parasites over the 10 year period. Parasitism (< 10% at all sites) does not appear to be a limiting mortality factor affecting the effectiveness of R. conicus.

EFFECT OF ESTROGEN ON LIPOPROTEIN PROFILES OF NON-LACTATING DAIRY COWS. L. F. Ferreri and D. H. Gleockler. Dept. of Dairy Sci., V.P.I. & S.U., Blacksburg, VA 24060

Estrogen is known to cause alterations in the distribution of serum lipoproteins in rats and man. Evidence from rat studies suggests estrogen modifies the normal catabolism of very low density lipoproteins (VLDL) into low density lipoprotein (LDL). In a preliminary experiment, four non-lactating Holsteins were injected subcutaneously with estradiol-17β (0.1 mg/kg) for one week. Serum was obtained and lipoprotein profiles generated using agarose gel filtration chromatography. Two of the four cows exhibited marked reductions in VLDL; 23.17% reduced to 4.16%, and 14.41% reduced to 3.16% (expressed as percent total lipoprotein). To obtain sufficient data for statistical validity the experiment was repeated with six additional cows. Unfortunately, little evidence for a reduction in VLDL occurred in these animals. Variations in the physiological status of the six additional animals (age, number of previous lactations, etc.) or variations in experimental procedure (e.g. time of the year) may be reasons for the failure to duplicate our earlier results.

FLOOR SPACE REQUIREMENT OF WEANED PIGS HOUSED IN A TRIPLE DECK NURSERY. C. L. Gaines*, S. R. Arthur*, K. L. Bryant and E. T. Kornegay. Dept. of Animal Science, VPI & SU, Blacksburg, Va. 24061

Three trials using 240 crossbred pigs weaned at an average age of 23 days were conducted in an environmentally controlled, triple deck nursery with six, eight or ten pigs per 4 x 4 ft cage (2.7, 2.0 and 1.6 sq ft of floor space per pig, respectively). Pigs housed in the middle deck consumed more feed, grew faster and were slightly more efficient than pigs housed in the bottom deck, with performance for pigs housed in the top deck intermediate. After three weeks, pigs housed ten per cage consumed less feed and grew slower than pigs housed six per cage with feed intake and gain intermediate for pigs housed eight per cage. Feed per unit of gain was similar, although overall, six pigs per cage required slightly more feed per unit of gain. Pigs housed on the upper decks were cleaner with no differences in cleanliness scores among pigs housed ten, eight or six per cage.

COMPARISON OF DEVELOPMENT OF ROOT-KNOT ON CISSUS QUADRANG-ULARIS AS INFLUENCED BY DIFFERENT METHODS OF INOCULATION WITH A SPECIES OF MELOIDOGYNE. Lorraine S. Graney* and L. L Miller, Dept. of Plant Pathol. & Physiol., Va. Polytech. Inst. & State Univ., Blacksburg, VA 24061.

Three methods (M1,M2, or M3) of inoculation with a species of Meloidogyne were evaluated to determine their influence on galling and egg mass formation on basal stems and roots of Cissus quadrangularis. In each method tested, 30 egg masses (EM) were inoculated to a single plant grown in a 4-inch pot of steamed soil. In M1, a rooted transplant was inoculated by distributing the EM to four 1-inch-deep holes in the soil around the basal stem. The inoculum in M2 was introduced into four 4 mm square by 3 mm deep wounds in the stems a half-inch below the soil line of rooted transplants. In M3, the inoculum was placed at the bottom of a 1-inch deep hole into which a non-rooted stem cutting was planted. The plants were examined for galling and EM development after seven months. Stem galling occurred in M2 and M3 inoculated plants but not in M1 inoculated plants. Galling of the roots was observed in M1 and M3 inoculated plants but not in M2 inoculated plants. EM were not observed in the basal stem of plants inoculated by the three methods although from other experiments it has been learned that they may be formed occasionally in very old infected plants. EM were formed on roots of M1 and M2 inoculated plants but not on M3 inoculated plants. It is concluded that the nematode does not reproduce as readily in stems as it does in roots.

SEARCH FOR NUTRIENT RELATIONSHIPS TO SCLEROTINIA BLIGHT AND CYLINDROCLADIUM BLACK ROT DISEASES IN PEANUTS. D. L. Hallock and N. L. Powell, Tidewater Res. and Cont. Educ. Ctr. and Dept. of Agronomy, VPI & SU, Suffolk, Va. 23437 and Blacksburg, Va. 24061.

Soil samples were obtained in 1975 and 1976 from non-diseased areas and areas of peanut fields infected with Cylindrocladium black rot (CBR) caused by Cylindrocladium crotalariae. Also, soil plus foliar samples were obtained in a similar manner near crop maturity in 1978 from peanut fields infected with CBR and other fields infected with Sclerotinia blight caused by Sclerotinia sclerotiorum. These soil samples were analyzed for pH and contents of available P, K, Ca, Mg, Mn and Zn and the foliage for contents of P, K, Ca, Mg, Mn, Zn, Cu, and Fe. Analyses of samples from diseased areas were compared with similar analyses of samples from the non-diseased areas in search of possible relationships between nutrient contents and these diseases.

Soil pH averaged slightly higher in CBR-free areas adjacent to infected areas. Average levels of available soil K were 20 to 30 lb/a lower in both CBR and Sclerotinia-free areas than adjacent infected areas. Peanut foliage from healthy plants averaged lower in K and Zn, and higher in Mn and Cu than plant foliage from Sclerotinia-infected plants. Peanut foliage from CBR-free areas averaged higher in K, Mg, P, Mn, Zn, and Fe than plant foliage from CBR-infected areas nearby.

VIABILITY OF MICROSCLEROTIA OF CYLINDROCLADIUM BLACK ROT FOLLOWING PASSAGE THROUGH THE GASTROINTESTINAL TRACT OF THREE AVIAN SPECIES. R. B. Hiller and P. F. Scanlon. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

A study was conducted to investigate the possible role of birds in spreading *Cylindrocladium Black Rot* (CBR) of peanuts. Part of the study was to determine the survival of CBR microsclerotia (*ms*) in the avian (Canada Coose, *Branta canadensis*; Bobwhite Quail, *Colinus virginianus*; and Japanese Quail, *Coturnix japonica*) gastrointestinal (CI) tract. Water-suspended *ms* were introduced by intubation into crops of individually housed birds as follows: 100 *ms* in 6 Canada Geese, 300 *ms* in 6 Canada Geese; 5,000 *ms* in 12 Canada Geese, 5,000 *ms* in 12 Bobwhite Quail; and 5,000 *ms* in 12 Japanese Quail. Feces were collected daily over 5 days and cultured to determine viability of microsclerotia following CI passage. In all cases no viable *ms* were recovered. In 15 Canada Ceese 5,000 *ms* were given enclosed in porous bags of synthetic material. These were inserted directly into the crops of geese. Bags were recovered from 13 geese as follows: Day 1, 3 intact bags; Day 2, 7 damaged bags, Day 3, 2 damaged bags; Day 4, 1 damaged bag. A total of 5 viable microsclerotia were recovered from 2 of the 3 bags recovered Day 1. The overall results indicate that microsclerotia of CBR fail to survive passage through the avian CI tract. Even when extraordinary efforts were made to protect the *ms* within the CI tract survival was negligible.

BONE CHARACTERISTICS AND FEEDLOT PERFORMANCE OF DEVELOPING BOARS AS INFLUENCED BY RESTRICTED CROWTH RATE AND ELEVATED MINERALS, VITAMINS AND PROTEIN LEVELS. G. A. Kesel, D. F. Calabotta, J. W. Knight, H. P. Veit, H. R. Thomas, D. R. Notter and E. T. Kornegay, Departments of Animal Science and Veterinary Science, VPI&SU, Blacksburg, Virginia 24061

Following necropsy at 10 ± 3 day intervals from 80–220 days of age, it was found that restricting the energy intake by 25% that of the full fed animals resulted in the middle metacarpal bone being significantly ($P < .01$) longer. The breaking strength, fat content of the bone and the percent fat free bone ash tended to be lower in the restricted energy level. In those boars receiving vitamins and minerals elevated to 150% National Research Council (NRC) requirements a significantly ($P < .01$) greater metacarpal bone breaking strength was observed. A significantly higher ($P < .05$) percent fat free bone ash and a lower ($P < .05$) ether extract was also observed in the elevated vitamin and mineral levels.

TESTOSTERONE RESPONSE OF BOARS TO VARIOUS EXOGENOUS HORMONE CHALLENGES AT THREE ACES. H. C. Kattesh, J. W. Knight, F. C. Gwazdauskas, H. R. Thomas and E. T. Kornegay. Depts. of Anim. Sci., VPI&SU, Blacksburg, Va. 24061

Forty-four boars were randomly assigned to one of three age groups (150 ± 7, 200 ± 7 or 250 ± 7 days of age) to examine endogenous testosterone (T) concentrations in response to one of four exogenously administered treatments. Four boars at each age were administered either human chorionic gonadotrophin (HCG; 1000 U.S.P. units intravenously), adrenocorticotrophin (ACTH, 100 IU intravenously) or testosterone proprionate (TP; 25 mg intramuscularly). The remaining boars were given 0.9% NaCl (S; 5 ml intravenously). Blood was collected from each boar at -120, -90, -60, -30 and 0 min pre-treatment and 15, 30, 45, 60, 75, 90, 105, 120, 150, 180, 210, 240, 270, 300, 330 and 360 min post-treatment via an indwelling anterior vena cava catheter. Plasma T was quantified by radioimmunoassay. Within treatment boars receiving HCC, ACTH or S responded similarly ($P > .10$) across the three age groups for T. Plasma T was elevated ($P < .05$) by 30 min ($4.7 \pm .5$ ng/ml) and 15 min (5.5 ± 1.1 ng/ml) post-treatment in boars given HCG and ACTH, respectively, compared to the S ($1.0 \pm .3$ ng/ml) group. T in HCC treated boars peaked by 90 min post-treatment, declined slightly until 210 min and increased thereafter. T in ACTH treated boars plateaued by 45 min post-treatment and began to decline by 90 min post-treatment. Plasma T levels for TP treated boars differed ($P < .05$) over time among the age groups.

GOAL PROGRAMMING FOR RESOURCE MANAGEMENT DECISIONS. J. E. Hotvedt* and W. A. Leuschner. Dept. of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

Natural resources are usually managed to provide an optimal mix of products and services in the most efficient manner possible. Linear programming has been the prevalent planning technique but has been critically viewed as too restrictive since it implicitly assumes a single objective predominates. Most institutions have many goals and in public resource management the traditional economic objective, maximum net revenue, has a low priority. Furthermore, the linear programming requirement of transforming all resource objectives into one unit, often dollars, has been viewed from impossible to objectionable, particularly for non-market goods such as wildlife or watershed output.

Goal programming has been suggested as a more appropriate allocation technique. Multiple objectives (goals), in different measurement units, may be specified (e.g., elk AUM, recreation user days, or acre feet of water) and the total deviation from these goals minimized. Priorities may be specified for resource uses and trade-offs analyzed.

Goal programming for natural resource management has been applied in multiple-use and timber management in public forestry, public range management, and is currently being applied to industrial forest management.

THE EFFECTS OF DRAINAGE ON A POCOSIN IN ISLE OF WIGHT, VIRGINIA. W.F. Kitchel, S.K. Thomas, and C.D. Peacock, Jr., Dept. of Agronomy, VPI & SU, Blacksburg, Va. 24061

Pocosins are as the Indians described them, swamps, or poorly drained areas of soil on top of a hill. They occur at the highest elevations in Isle of Wight County, ranging from 75 to 85 feet in elevation. Areas are broad and winding and range from 40 to more than 2500 acres in size.

In surficial sediments are relatively old in comparison to surrounding soils, being about 2 million years old, and are fairly deeply weathered with clay enrichment to about five feet. However, soils are generally Typic Ochraquults and Typic Paleaquults due to the fact that there is no external drainage from these old marine flats with no drainageway dissection.

Soils are principally coarse loamy and fine loamy so drainage ditches and agricultural tile is easily installed and maintained. There are fewer limitations on logging practices, longer harvest periods, more opportunities for intense forest management, and field crop production is increased.

PHOSPHORUS AND PROTEIN REQUIREMENT OF DEVELOPINC BOARS. E. T. Kornegay and H. R. Thomas. Tidewater Res. Cont. Ed. Center, VPI & SU, Suffolk, VA 23437

Two trials using 192 crossbred boars initially weighing 47 lb were conducted to evaluate diets containing three levels of calcium and phosphorus, National Research Council (NRC), 25% higher and 50% higher, fed in combination with two levels of protein, NRC and two percentage units higher. Average daily gain appeared to be improved initially and feed per gain was lowered when pigs were fed the diet containing 25% higher calcium and phosphorus as compared to pigs fed the diets containing NRC and 50% higher levels. However, during the latter part of the test and overall there were no differences between the various levels of calcium and phosphorus. The effect of dietary calcium and phosphorus levels on pad, feet and structural soundness scores and toe leisons was inconsistent and suggest little, if any, effect on these parameters. Bone ash and breaking strength of the metacarpal were increased linearly as the level of dietary calcium and phosphorus increased. Average daily gain and feed per gain favored pigs fed the higher protein level during the first phase of the test, but were not different during the latter phase. Final pad scores and bone ash were greater for pigs fed the higher protein level. There appeared to be no effect of protein level on soundness and feet scores, toe leisons and bone breaking strength. These results provide little support to the belief that growing and developing boars require higher calcium and phosphorus and protein levels than currently recommended by NRC for market hogs.

ESTRUS DETECTION AND A.I. IN VIRGINIA DAIRY HERDS.
J. A. Lineweaver and F. C. Gwazdauskas. Dept. of Dairy
Science, Va. Polytechnic Inst. and State Univ., Blacksburg,
Va. 24061.

A survey was conducted among Virginia dairy herds partic-
ipating in the Dairy Herd Improvement Records Program.
Responses were obtained from 508 of 846 herds. Daily estrus
checking frequency was highest at twice daily for 68.5 per-
cent of the herds while 14.8 percent checked 3 times daily.
Fifty-two herds or 12.9 percent checked estrus more than 3
times per day and 4.9 percent used a bull and did not check
estrus at all. All herds averaged 2.36 estrus checks daily
for an average duration of 15.96 minutes for each check.
Overall, 86 percent of all cows and 42 percent of all
heifers are bred by artificial insemination (A.I.). A.I. is
performed by professional technicians in 47 percent of all
herds while dairymen perform 46.3 percent and the dairyman
and technician team up for 1.8 percent. Seventy-eight per-
cent of herds breed cows artificially in the morning and/or
evening while 28.9 percent reported noon A.I.

ELECTRONIC PREGNANCY DIAGNOSIS IN CATTLE. J. A. Lineweaver
and R. G. Saacke*. Dept. of Dairy Science, Va. Polytechnic
Inst. and State Univ., Blacksburg, Va. 24061.

Ninety-four beef cows were checked for pregnancy using
the cow pregnosticator, manufactured by Anamark, Inc.
This equipment works on the sonar principle. An external
sensor is pressed against the skin in the animal's para-
lumbar area. Oil is used as an air seal between the sensor
and the animal's skin. Small amounts of transmitted
energy are reflected from different internal body tissues,
collected and displayed on a screen. Rectal palpation was
used to age embryos, verify successful breeding dates, and
diagnose non-pregnancy. Fifty of 56 cows, pregnant between
30 and 47 days, were diagnosed correctly using the preg-
nosticator. Of 22 cows pregnant between 10 and 29 days,
19 were correctly diagnosed. Three cows bred 1 and 2 days
were correctly diagnosed as non-pregnant. Thirteen non-
pregnant cows were incorrectly diagnosed pregnant. Overall
results show 76.6 percent correct diagnosis while 23.4 per-
cent were diagnosed incorrectly.

MATING AND OVIPOSITIONAL STATUS OF ADULT FEMALE
CIGARETTE BEETLES KILLED BY DDVP APPLICATION IN
TOBACCO WAREHOUSES. J. S. Long, M. H. Tickle,*
and M. A. Manzelli. Philip Morris Research Center
P. O. Box 26583, Richmond, VA 23261.

The mating and ovipositional status of feral
cigarette beetle females were studied. Of those
females killed by DDVP and collected for exami-
nation, 96.3% had mated and the average number of
eggs/female was 19.7. One hundred percent of
female cigarette beetles collected from black-
light suction light traps were not virgin with
the average number of eggs/female being 5.3.
Live females collected from warehouses and
allowed to oviposit in the laboratory produced
an average of 43.3 offsprings/female. DDVP usage
contributes to overall population reduction by
preventing young gravid females from infesting
the commodity.

COMPARISON OF CHAROLAIS, LIMOUSIN, MAINE-ANJOU AND SHORTHORN
BULLS ON SHORTHORN COWS. T. J. Marlowe, E. T. Barnes* and
J. S. Copenhaver, Animal Science Department, VPI&SU

Limousin and Maine-Anjou bulls used AI, others naturally
as cleanup bulls, except for first year when Shorthorn bull
was turned with 15 cows during regular breeding season. Two
calf crops (1976-1977) produce 115 calves weaned, with 11
calves lost. Data were adjusted for year, age and sex of
calf and age of dam. No. of each kind of calf and LS means
are shown in the table.

Sire breed	Calves weaned	Birth weight	Adj ADG	Adj 205 day wt.	Grade	Cond.
Charolais (C)	21	91.9	2.13	529	13.0	8.3
Limousin (L)	34	79.1	1.97	484	13.0	8.8
Maine-Anjou (M-A)	38	84.6	2.02	499	13.1	8.7
Shorthorn (Sh)	22	78.0	1.82	453	12.2	8.0
Combined	115	82.8	1.99	491	12.8	8.5

Birth wt was signif lower for Sh sired calves and highest for
C sired calves, with L and M-A calves intermediate. ADG and
wn wt followed the same pattern as birth wt. M-A sired
calves av. 15 lb heavier than L sired calves, but 30 lb
lighter than C sired calves. No diff in grade of C, L or
M-A sired calves, all of which av. about one grade point
higher than Sh sired calves. When all XB's were compared
to all SB calves, diff were 7.2 lb at birth, .22 lb ADG, 51
lb wn wt, .8 grade point and .6 cond score in favor of XB
calves. M-A matings produced 5 percentage point more calves
weaned than L matings (67.7 vs 62.7%).

COW BREED EVALUATION IN THE SOUTHAMPTON HERD. T. J. Marlowe
and W. E. Burgess*, VPI&SU, Blacksburg, and Southampton Cor-
rectional Center, Capron, Virginia

Heifers were exposed to Angus (A) bulls 75 days annually
(1971-75) as yearlings or 2-yr-olds, except Char (C) were
bred to C bulls. After first calving, all were exposed to
Sim x Her (SH) bulls for 75 days each in 1972-77, except C
and half of A cows were exposed to bulls of their own breed.
Data were analyzed separately for heifers and cows by LS pro-
cedures. Model included effects of year, sex, age and breed
of cow, and interactions of BxY and BxS. Number of each kind
of cow exposed, along with % calf crop and performance data
to weaning, are shown in table. Ax indicates A cows bred
first to A bulls and thereafter to SH bulls.

Br of cow	Heifer performance					Cow performance				
	No. exp	% wean	W.wt (lb)	Gr	lb ca/ C exp	No. exp	% wean	W.wt (lb)	Gr	lb ca/ C exp
AA	30	73.3	372	11.1	273	118	83.9	412	12.4	348
CC	39	59.0	481	12.5	284	100	71.0	521	13.2	391
Ax	33	72.7	372	11.1	270	125	82.4	444	12.4	366
CA	44	70.4	410	12.2	289	125	89.6	479	13.1	429
FA	42	88.1	443	12.1	390	129	89.9	514	13.2	473

Breed of cow diff. were signif. for ADG, W.wt and grade but
not for age or cond. at weaning. Crossbred (XB) cows weaned
10 more calves and 7,700 lb more calf wt per 100 cows exposed
than did the straightbreds (SB). Among XB matings, FA cows
weaned 53 lb more calf than CA cows and 99 lb more than AA
cows producing XB calves. Calf grades also favored XB and C cows.

COOPERATIVE BEEF CATTLE BREEDING RESEARCH. T. J. Marlowe
and R. C. Oliver*, VPI&SU, Blacksburg, and Department of
Corrections, Richmond

A cooperative cattle breeding research project was initi-
ated between the Animal Science Department of VPI&SU,
Blacksburg, and the Department of Corrections, Richmond, in
1968 to: 1) evaluate several breeds as sire breeds; 2) com-
pare several kinds of XB and SB cows produced in obj. 1; and
3) determine best comb. of breeds and mating schemes for
maximizing production. In phase I, eight sire breeds were
evaluated and those findings reported at earlier meetings.
In phase II, 3 SB and 9 XB cow types were evaluated at five
locations. Results of cycles 1 and 2 are reported here for
3 of the 5 herds involved. Detailed results are reported in
the following abstracts. In general, XB cows were superior
in fertility, calf mortality, and lb calf produced. Un-
weighted averages over all locations for XB vs SB cows were
12.5 vs 15.4% for open cows, 8.6 vs 12.7% for calves lost,
79.0 vs 73.5% for calves weaned and 377 vs 295 calf weaned
per cow exposed. Calves out of XB cows also graded 1/3 USDA
grade higher. Holstein X (either FA or FH) cows were the
top performers at all locations. Corresponding values for
FH cows were 10.4%, 7.9%, 83.9%, and 410 kg calf per cow
exposed. When Best XB cows were compared to SB controls, diff
ranged from 32 to 147 lb, av. 113.1 lb over all 5 locations.
For the 1978 calf crop the diff amounted to 126,429 lb extra
calf at wn; valued at $120,107.55 at present market prices.

COW BREED EVALUATION IN THE BEAUMONT HERD. T. J. Marlowe and E. S. Strawderman*, VPI&SU, Blacksburg, and James River-Powhatan Correctional Center, State Farm, Virginia

During 1973-75, 150 heifers of Char x Her (CH), Hol x Her (FH), Short x Her (S̄H) and Her (HH) breeding calved as 3-yr-olds. All heifers were exposed to Angus (A) bulls for 75 days annually and thereafter to A or Sim x Ang (SA) bulls thru the 1978 crop, except that half of the HH heifers and cows were bred to H bulls. Data were analyzed separately for heifers and cows by LS procedures. The model included effects of year, age and breed of cow, sex and BxY and BxS interactions. Hx indicates HH cows bred to produce XB calves.

Br of cow	Heifer performance					Cow performance				
	No. exp	% wean	W.wt (lb) Gr		lb ca/ C exp	No. exp	% wean	W.wt (lb) Gr		lb ca/ C exp
CH	27	66.7	430	12.8	287	103	70.9	466	13.2	330
FH	25	84.0	470	13.0	395	101	77.2	491	13.3	379
S̄H	24	79.2	410	13.0	325	108	84.2	446	12.8	375
Hx	23	69.6	361	11.1	251	100	62.0	376	12.0	229
HH	27	77.8	341	10.9	265	129	74.4	374	12.2	278

Cow breed diff. were signif. for ADG, W.wt, grade and cond. but not for calf age. XB cows weaned 71 lb more calf per cow exp. from heifers and 83 lb more from cows or 81 lb more over 5 seasons than SB. Corresponding XB-Hx were 85, 132 and 121 lb, resp. XB cows ranked (H to L), FH, S̄H and CH. FH cows weaned 10.4 more calves and 10,700 more lb calf per 100 cows exposed than did HH cows. Offspring of XB cows graded 1/3 USDA feeder grade higher than offspring of SB cows.

COW BREED EVALUATION IN THE STATE FARM HERD. T. J. Marlowe and E. S. Strawderman*, VPI&SU, Blacksburg, and James River-Powhatan Correctional Center, State Farm, Virginia

Seven kinds of cows were compared in 1975-78, Ang x Her (AH), B. Sw x Her (BH), Char x Her (CH), Hol x Her (FH), Sh x Her (S̄H), Sim x Her (SH), and Her (HH). 427 2-yr-olds were exp. to A bulls (except AH cows exp. to S̄ and half HH cows to H bulls) for 75 da annually. Thereafter, all cows bred to S̄ bulls (except HH cows bred to A bulls and half HH cows to H bulls). Data analyzed separately for heifers and cows by LS procedures. Model included year, cow breed, sex, BxY, BxS and cow age. Nos. and LS means are shown in table.

Br of cow	Heifer performance					Cow performance				
	No. exp	% wean	W.wt (lb) Gr		lb ca/ C exp	No. exp	% wean	W.wt (lb) Gr		lb ca/ C exp
AH	59	79.7	403	12.0	321	92	75.0	436	12.6	324
BH	46	84.8	451	11.9	382	59	72.9	467	12.9	340
CH	54	75.9	429	12.7	326	89	70.8	464	13.4	328
FH	60	89.3	468	13.0	418	92	80.4	479	13.1	383
S̄H	43	90.7	418	12.2	379	66	74.2	444	12.6	329
SH	51	80.4	422	12.6	339	85	74.1	446	13.2	330
Hx	55	76.4	378	11.9	289	107	81.3	411	12.5	334
HH	59	66.1	380	11.6	251	74	75.7	364	11.5	275

XB cows weaned 7 more calves that av. 75 lb more than SB calves and 46 lb more than XB calves out of SB cows. FH cows superior to all others, weaning 132 lb more than SB matings, 79 lb more than SB cows with SB calves and 39 lb more than closest competitor (BH).

PLANT POPULATION AND PLANTING CONFIGURATION EFFECTS ON INSECT POPULATIONS IN ESSEX SOYBEANS. J. W. Murphy and J. C. Smith.* Dept. of Entomology, V.P.I. & S.U., Blacksburg, Va. 24061

Essex variety soybeans were planted July 5, 1978 in 12, 24 and 36 inch row spacings. Within each row spacing were populations of 1, 2 or 4 plants per square foot corresponding to 43,560, 87,120 and 174,240 plants per acre, respectively. Weekly shake cloth observations revealed that 36 inch row spacings had significantly higher numbers of predaceous insects and the green cloverworm, Plathypena scabra (F.). There were no differences in numbers of phytophagous insects in plant populations of 1, 2 or 4 plants per square foot. There were higher numbers of predaceous insects and green cloverworms in populations of 4 plants per square foot, but they were not significantly different from those found at 2 plants per square foot. Generally, highest numbers of phytophagous and predaceous insects were found in those planting configurations with the widest row spacings and densest plant populations within the rows.

COMPARISON OF RANDOM AND SELECTED SITES FOR THE CULLEN SERIES IN GREENSVILLE COUNTY. C.D. Peacock, Jr., A.C. Blackburn, and W.J. Edmonds, Dept. of Agronomy, VPI & SU, Blacksburg, Va. 24061

A comparison of the means of selected pits versus random sites of the Cullen Series was made to determine the significance, if any, of the characteristics used to classify the soil. The characteristics used to evaluate the means were percent clay, silt, silt plus very fine sand, and sand from the particle size control section and solum thickness. The evaluation was based on six selected pits and twenty three random site samples. A SINGLE CLASSIFICATION ANOVA WITH UNEQUAL SAMPLE SIZE was used to determine the significance of the means at the 90 percent confidence level. The two methods were found to be not significantly different although the random sites method established a more narrow range at one standard deviation.

POPULATION DENSITIES OF PLANT PARASITIC NEMATODES IN AGRI-CULTURAL SOILS OF SOUTHEASTERN VIRGINIA. P. M. Phipps* and J. A. Fox. Dept. of Plant Pathology and Physiology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

In October 1978, 376 soil samples from approximately 1500 acres in Southampton County, Isle of Wight County, and the City of Suffolk were analyzed for plant parasitic nematodes. Each soil sample was composed of 25 to 30 systematically collected soil cores (2-cm thick x 15- to 20-cm deep) from the plow layer in a 4-acre block of land. Nematode assays were performed by the elutriation-centrifugal flotation method. Using a threshold level of 25 nematodes per pint of soil, the 205 samples from soil planted to corn in 1978 showed 81% with Stunt nematode, 38% with Root Knot nematode, 35% with Ring nematode, 19% with Lesion nematode, 11% with Stubby Root nematode and less than 10% with various other nematodes (Lance, Spiral, Dagger). The 110 samples from soil planted to peanut in 1978 showed 89% with Root Knot, 56% with Stunt, 50% with Ring, and less than 10% with various other nematodes (Spiral, Lance, Lesion, Dagger, Stubby Root, Sting). The 23 samples from soils planted to soybeans showed 74% with Stunt, 70% with Root Knot, 40% with Spiral, 35% with Ring, 22% with Stubby Root, and less than 10% with various other nematodes (Dagger, Lance, Cyst, Lesion). This survey represents the initial stage of a long-range study to assess needs for nematode control in field crops.

SIMULATING THE SPREAD OF SOUTHERN PINE BEETLE INFESTATIONS. D. D. Reed*, H. E. Burkhart and W. A. Leuschner, Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061

A model has been developed to simulate the rate of spread of southern pine beetle (Dendroctonus frontalis, Zimm.) (SPB) infestations. The model has two principal functions: (1) a function to predict the number of trees killed per day, and (2) a function to predict the probability of the infestation becoming inactive. Spot growth through time can be simulated with these two relatively simple functions.

A FORTRAN program was written for this model and was tested with data collected from eleven independent sample SPB spots. There were 270 trees killed on the independent sample plots over a period of approximately 120 days from June to October. The average of ten simulation trials was 252.6 trees killed. Thus, the simulation program predicted 6.45% fewer trees killed than was observed in the test data. The observed number of trees killed in the test data was within the range of the predicted values from the ten simulation runs.

EFFECT OF SULFUR APPLICATION ON CORN YIELD AND COMPOSITION.
R. B. Reneau, Jr. Department of Agronomy, VPI & SU,
Blacksburg, Virginia, 24061.

Field experiments with corn (Zea mays L.) were con-
ducted during the past two years to evaluate growth as
influenced by S application. During this time when
responses to S were measured, the soil extractable S level
in the surface horizons was below 25 Kg/ha and adequate
subsoil S, if present, was not available. Increased yields
with S application occurred in coarse-textured soils and in
soils where root penetration into the subsoil was inhibited.
Both chemical and physical inhibition of roots into subsoil
materials have been observed in 1977 and 1978. Sulfur
responses appear to be enhanced by moisture stress and
probably results from limited root proliferation during
these periods. Increased yields ranged from 15 to 40
percent.

Chemical composition of the tissue has shown that
protein N was not affected, but S and N to S ratios changed
significantly. These changes in S and the N to S ratio in
the tissue also appears to be related to time of sampling
(days after emergence).

FACE FLY AND HORN FLY CONTROL BY MEANS OF BACKRUBBERS.
J. E. Roberts, Sr. Dept. of Entomology, Va. Polytechnic
Inst., Blacksburg, Va. 24061

The purpose of this test was to measure the effectiveness
of Ravap ® insecticide and Cow Life-Cattle Rub backrubbers
with face flaps attached.

The treated herd was subjected to forced treatment in
that the cows had to go under the backrubbers with the fly
flaps attached to obtain mineral. Backrubbers with attached
fly flaps were placed across the entrance to a small pen. A
mineral box was placed inside the pen. The cows treated
themselves as they passed under the self treatment device to
obtain mineral.

Horn fly counts were based on the actual count of Horn
flies on one side of the animal, multiplied by two for the
total number per animal. Face fly counts were confined to
the actual number of flies on the face of the animals. Both
face and Horn fly counts were made with the aid of binocular
field glasses.

Ravap on Cow Life-Cattle Rub backrubbers with face flaps
gave poor control of Face flies and good to excellent control
of Horn flies during this test.

CHEMICAL CONTROL OF HOG LICE. J. E. Roberts, Sr. Dept. of
Entomology, Va. Polytechnic Inst., Blacksburg, Va. 24061

A test demonstration for control of hog lice was con-
ducted in Buckingham County, Va., from June to August of
1978 on Yorkshire and Hampshire brood sows. This test
compared Starbar GX 118 (Prolate ®) to pretreatment counts
and untreated check animals.

Two rates of this insecticide (1 to 2 parts H_2O and 1 to
5 parts H_2O) were applied as a pour-on. Animals were
treated along the backline from the hips to the neck area.
Approximately 1 oz./100 lbs. body wt. was applied to each
animal by means of a calibrated dipper.

Excellent control was obtained for a period of three
weeks with both rates. The cooperator was well pleased with
the results of this material. There were no adverse effects
on the animals or the applicator.

FACE FLY AND HORN FLY CONTROL WITH RABON ORAL LARVACIDE
ADDED TO MINERAL MIXTURE. J. E. Roberts, Sr., and H. J.
Gerken, Jr. Dept. of Entomology, Va. Polytechnic Inst.,
Blacksburg, Va. 24061

The purpose of this test was to measure the effectiveness
of Rabon ® Oral Larvacide in the control of flies on cattle.

Four similar herds of Angus, Herefords, and Shorthorn
crosses were selected; two at site A and two at site B
approximately 10 miles apart. One was used as a control
herd and one was treated with Rabon Oral Larvacide as a
mineral additive at each test site. Seven post-treatment
counts were made at site A and ten post-treatment counts at
Site B. The test herd at site A consisted of 46 animals.
The test herd at site B had 101 cows and the control herd
had 20 cows and their calves.

Horn fly counts were based on the actual count of horn
flies on one side of the animal and multiplied by two for
the total number per animal. Face fly counts were confined
to the number of flies on the face of the animals. Both
Face and Horn fly counts were made with the aid of binocular
field glasses.

Rabon Oral Larvacide gave poor control of both Face and
Horn flies in these tests.

FACE FLY AND HORN FLY CONTROL BY MEANS OF RABON IMPREGNATED
EAR TAGS. J. E. Roberts, Sr., and W. H. McClure. Dept. of
Entomology, Va. Polytechnic Inst., Blacksburg, Va. 24061

The purpose of this test was to measure the effectiveness
of Rabon ® ear tags for the control of face flies and horn
flies on cattle.

Two similar herds of Angus-Herefords and Shorthorn crosses
were selected; one to be used as a control herd; one to be
treated with Rabon ® ear tags, one in each ear of the test
animals. Eight post-treatment counts were made. There were
36 animals in the test herd and 63 animals in the control
herd.

Horn fly counts were based on the actual count of horn
flies on one side of the animal, multiplied by two for the
total number per animal. Face fly counts were confined to
those around the eyes and nose of the animal. Ten animals
per herd for counts were considered adequate representation
of the herd.

Rabon ear tags showed variable efficiency throughout the
test and gave better control of horn flies than face flies.

DEVELOPMENT OF ARTIFICIAL DIETS FOR REARING BENEFICIAL
INSECTS. D. J. Rowe and L. T. Kok. Dept. of Entomology,
VPI & SU, Blacksburg, Va. 24061.

The development of artificial diets for rearing insects
has increased significantly during the past few decades.
This has partly been in response to the demand for large
numbers of insects required in various aspects of pest man-
agement and research. Insect colonies may be reared and
studied in a limited amount of space throughout the year
yielding specimens of uniform age and quality. A thorough
understanding of insect nutrition is essential to the success-
ful formulation of an artificial diet. It must possess all
the vital nutrients in the correct proportions needed for
normal growth, development and reproduction of that species.

The presence of certain non-nutritive factors play key
roles in the host selection and specificity of many insect
species. Chemical components of the host often act as
attractants and/or phagostimulants. Physical characteristics
such as texture, shape and water content also affect induc-
tion and maintenance of feeding.

Virtually all of the outstanding results from introductions
of beneficial insects for pest control have been achieved by
highly host specific natural enemies. This attribute largely
determines an insect's biological control potential, but also
makes it much more difficult to mass produce. Efficient pro-
pagation of these insects cannot be easily accomplished until
determinations of all requirements (both nutritional and other-
wise) are made and successfully incorporated into a laboratory
rearing program.

PHEROMONE TRAPPING FOR CLEAR-WINGED BORER PESTS OF WOODY ORNAMENTALS IN VIRGINIA. P. B. Schultz and L. A. Parnell Virginia Truck & Ornamentals Research Station, Va. Beach, VA 23455.

Pheromones offer an inexpensive and simple method of monitoring clearwing borers. The use of the pheromones in conjunction with sticky traps provides information on pest abundance and life history for the attracted species. In 1978 pests monitored with the attractant cis, cis-3,13-octadecadien 1-Ol acetate, were the dogwood borer, Syanthedon scitula; oak borer, Paranthrene simulans; and lilac borer, Podesia syringae.

Trap collections indicate dogwood borer emergence occurred from May to early October in eastern Virginia. A total of 164 males were collected from a site in Ghesapeake, Virginia; substantially fewer males were collected at the other sites. The variation may be the result of impure pheromone or of different population levels of dogwood borer at each site. Suppression measures for this species should begin in late May and continue through October.

Emergence of the oak borer occurred from late May to mid-June in all regions where the insect was trapped. This species would require only one treatment in early June for its suppression.

Lilac borers were collected from mid-May to mid-July at all trap sites in Virginia. Suppression measures for this species should begin in May in eastern Virginia and in June in the remainder of the state.

EVALUATION OF TECHNIQUES USED FOR THE SIMULTANEOUS EXTRACTION AND ANALYSIS OF GIBBERELLIC AND INDOLE-3-ACETIC ACID FROM SOYBEAN TISSUE. D. G. Shilling* and D. M. Orcutt. Dept. of Plant Pathology and Physiology, VPI&SU.,Blacksburg, Va. 24061.

Three procedures (PI,PII,PIII) were evaluated to determine the best method for simultaneously extracting gibberellic acid (GA_3) and indole-3-acetic acid (IAA) from Glycine max (L.) Merr. All procedures utilized solvent partitioning for purification of plant extracts, but differed in extraction solvents, pH at which partitioning was carried out and chemicals used to adjust pH. Gas-liquid chromatography (GLC) was used to determine recovery and extraction efficiency of GA_3 and IAA.

Optimum conditions for maximizing recovery of IAA and GA_3 were determined prior to a comparison of the three procedures. Recovery of IAA and GA_3 was found to be enhanced by the addition of antioxidant and careful manipulation of evaporation steps. Internal standards were run for all three procedures both in the presence and absence of tissue. Tissue was also run through each procedure without added standard (Blank). In all cases, the presence of tissue resulted in lower recoveries of internal standards. The best recovery of internal standard in the presence of tissue occurredwith PIII (88% IAA and 61% GA_3). The most efficient solvent for extracting endogenous GA_3IAA was methanol; yielding 9 μg IAA/g dry weight of tissue. No GA_3 was detected in any of the blank tissue samples analyzed.

CARDUUS THISTLE RESPONSE TO ATTACK BY PHYTOPHAGOUS INSECTS. P. J. Sieburth*and L. T. Kok. Dept. of Entomology, VPI & SU, Blacksburg, Va. 24061.

The impact of insects attacking agricultural crops has been well documented, but the impact of phytophagous insects in restricting growth of unwanted plants has received less attention. Two biological control agents of Carduus thistles (noxious weeds) have shown plant responses which vary with the level of infestation. Rhinocyllus conicus Froelich, a weevil whose adults feed on thistle leaves and whose larvae feed within the thistle blooms, mainly restricts seed production at low levels of infestation. At high levels of infestation, the infested blooms are aborted with no seeds being produced. No secondary blooms are given off as a result of destruction of the terminal blooms.

Ceuthorhynchidius horridus (Panzer), a weevil attacking the crown of the thistle plant, mainly affects the meristematic tissues which are fed upon by the larvae. At high levels of infestation the growth point is initially destroyed. This subsequently results in the death of the plant. However, at low levels of infestation, new shoots are frequently produced despite death of the growth point. This response is also influenced by plant vigor. Highly stressed plants do not often recover, but vigorous plants are capable of recovery.

INSECT GONTROL ON PEANUTS BY PLANTING AND PEGGING APPLICATIONS. J. G. Smith. Tidewater Res. and Gont. Ed. Ctr., VPI & SU, Suffolk, Va. 23437.

Insect counts and damage ratings were made on Florigiant var. peanuts treated with various soil-applied systemic and foliar spray insecticides. Tobacco thrips, Frankliniella fusca Hinds, were controlled by Dacamox 15G @ 2.0ppb, Standak 75W @ 1.5 ppb, Disyston 15G @ 1.0 ppf and Azodrin 5 @ 1.0-spray. Those same treatments plus Dacamox 15G @ 1.0 ppf and Temik 15G @ 1.5 ppb allowed less thrips reproduction.

Potato leafhoppers, Empoasca fabae (Harris), were most numerous on plots treated with the fungicides, Bravo and Copper Gount N. Temik, Dacamox, Thimet, Nemacur and Nem-a-tak gave perfect early control. Dacamox gave nearly perfect control through August 21. The foliar sprays, Lannate, Sevin, Vydate and Azodrin were excellent treatments.

Southern corn rootworm, Diabrotica undecimpunctata howardi Barber, injury was severe. No soil-applied systemic significantly reduced injury over the control. Three spray applications of Lorsban gave best control in one test. Temik in-the-furrow plus Standak at pegging allowed the least injury in a second test.

Yield and value was significantly higher than the control from a split application of Temik, a split Temik plus Standak treatment and the Azodrin foliar treatment. Although not significantly different, the Lorsban spray treatment gave a value increase of $142.57/acre. This increase probably expressed the value of rootworm control.

COMPARISON OF THREE FLOORING MATERIALS FOR WEANED PIGS HOUSED IN A TRIPLE DEGK NURSERY. H. R. Thomas and E. T. Kornegay. Tidewater Res. Gont. Ed. Genter, VPI & SU, Suffolk, Va 23437.

Three trials using 312 crossbred pigs averaging 15.5 lb were conducted to evaluate the performance and feet pads of weaned pigs housed in triple deck cages in which three types of floors were used: .38 x 1.5 in galvanized woven wire, .75 x 1.5 in galvanized flat expanded metal and .5 x .5 in oil tempered wire cloth (quarry wire). Eight pigs were housed per cage (2 ft^2 floor space per pig). A 20% crude protein corn-soybean meal diet with 10% dried whole whey was fed until the average pen weight reached 25 lb and then an 18% diet without whey was fed to the end of test. The trials continued for either 42 or 49 days with an average final body weight of 48.8 pound. Average daily gain, feed intake, feed per gain and pad scores were not different (P .10) between pigs housed on the bottom, middle and top decks. There were no differences (P>.10) in average daily gain, feed intake and feed per gain between pigs housed in cages with woven wire, expanded metal and quarry wire. However, pad scores were higher (P< .05) indicating more cuts and abrasions for pigs housed in cages with quarry wire as compared to pigs housed in cages with woven wire and expanded metal.

USE OF GOMPUTER GAMES IN TEACHING PEST MANAGEMENT. Ronald W. Tillman Dept. of Plant Pathology and Physiology, Va. Polytechnic Inst. and State Univ. Blacksburg, VA 24061.

Pest management students must integrate various control methods into workable programs that are used to manage a range of pests. Because of time and resource limitations it is not possible to involve students in field experiences that enable them to practice problem solving and decision making. To overcome these limitations interactive computer simulations (didactic games) are being employed. Based on biological data, the games mimic realistic crop-pest situations and enable students to practice making critical decisions without jeopardizing the commodity or environment because of a bad decision. The games have four major sub-models: a weather generator; a commodity growth model; a pest development model and a pesticide attentuation model. Depending on the initial parameters chosen to drive the sub-models a variety of learning objectives is possible. Some of these objectives are the influence of weather on pest development and control, the interaction between biological, cultural and chemical control methods, the influence of one seasons pest control on subsequent pest levels, and the influence of economics on control decisions. Identical conditions can be duplicated in successive plays so that students can repeat situations and logically correct their mistakes. Because the games are independent of the time of year, students can experience several growing seasons in a short period of time at much less expense than on-the-job training.

THE USE OF PRESENT NET WORTH MODELS IN ESTIMATING THE
ECONOMIC IMPACT OF SOUTHERN PINE BEETLE (DENDROCTONUS
FRONTALIS, ZIMM.) ON TIMBER RESOURCES. F. C. Walters* and
W. A. Leuschner, Dept. of Forestry, VPI & SU, Blacksburg,
VA 24061.

Forest resource managers need an operational procedure to
accurately determine Southern Pine Beetle's (SPB) economic
impact on timber to establish control decision guidelines.
Benefit cost analysis provides a reliable framework. The
control program's benefits are estimated along with costs
to determine the difference in discounted net worth of a
timber stand with and without a control program. Program
implementation is indicated if the PNW difference is positive.

A study was undertaken to estimate the potential timber
benefits associated with SPB attack. The model was
operationally tested on a regional scale involving several
landownership classes in Central Mississippi. A sensitivity
analysis was then conducted on the individual input compo-
nents within the model to ascertain their effect on total
timber damage estimates. No attempt was made to identify
or estimate the costs associated with SPB control.

PREDICTION EQUATIONS BASED ON RELATIONSHIP BETWEEN A DAM'S
PERFORMANCE TRAITS AND THE WEANING WEIGHT OF HER PROGENY.
W. H. Whittle, Jr.* and T. J. Marlowe, Animal Science
Department, VPI&SU, Blacksburg, Virginia 24061

Data on 176 cows produced in 1970-75 and their 532 off-
spring produced in 1972-77 were analyzed by LS procedures
to adjust for effects of year, season, sire breed, dam breed,
age and sex of calf (except for dams) and age of dam. Dam's
performance traits (weight, grade and condition scores) at
weaning, 12 and 18 mo were then correlated with offspring
weaning weight. Data were subdivided into four sets: I =
1st calf only, II = 1st and 2nd calves, III = all calves,
and IV = same as III except records were adj. by Va BCIA
factors. Weaning weights in data sets II, III and IV were
converted to MPPA values for the correlation analyses. Pre-
diction equations for expected progeny weaning weights were
calculated by using residuals of the dam's performance traits
thru a set of stepwise regressions called Max R^2 Improvement.
In set I, 18 mo condition gave highest correlation ($r = .24$).
In set III, largest r came from 12 mo weight ($.15$) and 18 mo
weight ($r = .18$). r values in set IV were generally lower
and nonsignificant. All traits combined account for no more
than 10% of variables in weaning weight. In general, these
analyses indicate that prediction equations for weaning
weight from dam's performance traits are of limited use as
selection tools.

Astronomy, Mathematics, and Physics

Fifty-seventh Annual Meeting of the Virginia Academy of Science
May 8-11, 1979, University of Richmond

THE USE OF βX IN ABSOLUTE C*-EMBEDDING THEOREMS.
C.E. Aull, Department of Mathematics, Virginia Polytechnic
Institute and State University, Blacksburg, VA 24061
A property P is the (closed) C*-embedding absolute of
a property Q if a space X having property Q is C*-embedded
in every space having proper Q it is embedded in (as a
closed set) iff X has property P. A technique involving
quotients of subsets of βX is used in connection with the
closed C*-embedding absolutes for metacompact spaces,
P-spaces and Z-spaces.

THE MICROCOMPUTER AND MINICOMPUTER IN A PHYSICS OF MUSIC
COURSE. L. N. Beard. Dept. of Physics, Hampden-Sydney Col.,
Hampden-Sydney, Va. 23943.
An MMD microcomputer (8080-based) has been equipped with
inexpensive A/D and D/A converter circuits for use in a
Physics of Music course for non-majors. The analog-to-
digital converter has a maximum sampling rate of one 8-bit
word per 45 microseconds, which permits digitizing of audio
frequency waveforms. (At this sampling rate, 256 points
are sampled in about 0.01 sec.; this typically corresponds
to 2-4 cycles of a musical instrument waveform.) The data
can then be transmitted to a minicomputer (a PDP-11) for
harmonic analysis. Waveform synthesis can also be performed
using software in the minicomputer. Such waveforms are
transmitted to the microcomputer and its D/A interface for
graphical or audio output. Other applications, such as
studies of filter response, etc., will also be described.

THE APPLICATION OF CATASTROPHE THEORY TO NONLINEAR
OSCILLATORS. A.M. Buoncristiani and G.R. Webb. Dept.
of Physics, Christopher Newport College, Newport News, VA
23606.
A new approach to the problem of modeling phenomena
displaying a discontinuous behavior or an abrupt change in
state has been developed by the French topologist Rene Thom.
This approach, which Thom calls the theory of catastrophes,
is an outgrowth of the study of stability of dynamical
systems. The theory provides a different conceptual under-
standing of a phenomenon by presenting a simple global per-
spective of it.

Physical realizations of nonlinear oscillators often
display the discontinuous behavior that characterizes sys-
tems that are amenable to description by catastrophe theory.
Here we examine the limit cycle behavior of systems under-
going approximately sinusoidal oscillations. We show how
the theory of constrained catastrophes can be used in
obtaining the full unfolding of a differential representa-
tion of the system, and in constructing a differential
equation to serve as a model of the system if only experi-
mental data on the intensity surface for the system is
known.

We illustrate the theory by its application to a van der
Pol oscillator. (Aided by NASA grant NSG-1429).

SIMPLE PHYSICS DEMONSTRATIONS. D. R. Carpenter, Jr.
and R. B. Minnix. Dept. of Physics, VMI, Lexington
Va. 24450.
Summer short courses on demonstrations held at
VMI attract teachers from across the nation.
Demonstrations using the simplest of equipment
continue to have the highest appeal. Six from
recent short courses include a baking powder can
explosion using natural gas, a small neon or argon
bulb and a red-green diode rotated in a circle to
illustrate the alternating nature of household
voltage, and the effect of front vs rear wheel
skidding on a model car.
Also the change in resonant pitch of a plastic
soda straw as a reed pipe when its length is
shortened, the "burping" of a chilled Coke bottle
as it warms up with its opening partially blocked
by a dime, and the regelation of water using a "C"
clamp to apply pressure on ice in a brass cylinder.

ANALYSIS OF AN INHERENT LIMITATION TO COMPUTER PROGRAMS. Arthur Charlesworth. Dept. of Mathematics, University of Richmond, Richmond, Va., 23173

Consider the following variant of A.M. Turing's Theorem: no BASIC computer program can determine whether or not any given BASIC program, run with any given set of data, will go into an infinite loop. We observe that any sufficiently powerful programming language can be substituted for BASIC in this Theorem, without having to assume Church's Thesis, if we assume instead the following proposition: any programming language which is powerful enough to check programs for infinite loops must also allow statements which can be combined to form an infinite loop. This proposition would be false if it is possible to develop a programming language that is powerful and that, in addition, incorporates a clever new kind of loop structure which guarantees that all loops terminate.

As evidence for the proposition, we have the following result: Let $\mathcal{K}$ be a programming language which is powerful enough to write (1) an $\mathcal{K}$-syntax checking program, (2) an $\mathcal{K}$-interpreter, and (3) a program which, given a string S and a natural number n as data, generates all strings of length $\leq$ n whose characters belong to S; then $\mathcal{K}$ must allow statements which can be combined to form an infinite loop.

SOME MAPPING CHARACTERIZATIONS OF TOPOLOGICAL PROPERTIES. R.F. DICKMAN, JR.* Dept. of Math., Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

In this paper the author employs the techniques of analytic topology to resolve a thirty year old conjecture of Arthur H. Stone. The technique suggests that other problems of continua theory may be similarly examined.

Several related results and questions are presented.

LASER EXITED PHOTOACOUSTIC/OPTICAL ABSORPTION KINETICS IN II – VI SEMICONDUCTORS. G. W. Edwards* and R. W. Major. Dept. of Physics, Univ. of Richmond, Va. 23173.

Low-power millisecond laser pulses incident on ZnSe:Cu generate electron-hole pairs, modulating the absorption of a monochromatic probe beam incident on the sample at 90° to the laser beam. The observed signal fails to yield the kinetics of the optical excitation sought, because its shape is modified by a bulk heating effect.[1] We are applying the techniques of photoacoustic spectroscopy (PAS) in experiments designed to resolve this thermal contribution, whose removal from the overall absorption kinetics is expected to yield the purely optical excitation.

[1] R. W. Major and K. L. Elledge, J. Phys. Chem. Solids 19, 971 (1978)

A TRANSISTOR CURVE TRACER EXPERIMENT IN ELECTRONIC INSTRUMENTATION. F. P. Clay, Jr., C. E. Rash*. Dept. of Physics, Old Dominion Univ., Norfolk, VA 23508

An instrument for plotting a family of characteristic curves for a transistor can be implemented by a synthesis of circuits frequently studied in an electronics laboratory course. The output from the circuit uses either an x-y recorder or an oscilloscope in the x-y mode to display the data.

The instrument consists of a function generator, stair-step generator, driven constant current generator as well as summation amplifiers. Each sub-circuit is studied and tested using integrated circuits to implement the designs. These sub-circuits are part of the laboratory work in the early portions of the course.

The curve tracer experiment is used to demonstrate the interface problems that must be solved whenever an instrument is synthesized from sub-circuits.

FREE EDDIES IN A STREAMING STOKES FLOW. J. M. Dorrepaal. Department of Mathematical and Computing Sciences, Old Dominion University, Norfolk, VA 23508

The uniform streaming Stokes flow past two equal separated cylinders is considered where the direction of flow is perpendicular to the line joining the centers. Because of Stokes paradox, the problem reduces to solving for the first term of the inner expansion for low Reynolds number flow past two cylinders. It is found that fluid always moves through the gap separating the two cylinders no matter how small it is. When the gap width is less than 0.0446 times the cylinder radius, two free eddies form along the center line, one on either side of the gap. These eddies are completely isolated from the cylinder boundaries by the surrounding fluid and their appearence is a Stokes flow phenomenon not observed before. For smaller gaps both free eddies and boundary eddies are present. These interlace as the cylinders approach forcing the fluid which moves through the gap to take a winding path.

FRANCK CONDON FACTORS AND R-CENTROIDS FOR SIX DIATOMIC MOLECULES. P.M. Fazio*, and G.E. Copeland. Dept. of Physics, Old Dominion University, Norfolk, Va. 23508

The Franck Condon factor is defined as the square of the overlap integral and is so named because of its ties with the Franck Condon Principle. The r-centroid is the inter-nuclear separation associated with the electronic transition of a diatomic molecule. The physical meaning of these integrals are discussed. The construction of the wavefunctions, for two methods, are presented. Both methods employ the Morse Potential Energy function. The first method calculates the integrals using the analytic wavefunction of Morse and the second method has numerically constructed wavefunctions. Six molecules are studied; AsO, MgF, SrH, NO+ CO+ and N2. The results are compared with published results of other methods. The electronic states are $B^2\Sigma^+$ to $x^2\pi_{\frac{1}{2}}$ for AsO, A to X for NO+, $C^3\pi_u$ to $B^3\pi_g$ for N2, $A^2\pi_i$ to $X^2\Sigma^+$ for CO+, $A^2\pi$ to $X^2\Sigma$ for MgF and $D^2\Sigma^+$ to $X^2\Sigma^+$ for SrH.

MULTIDIPOLE PLASMA DATA ACQUISITION SYSTEM FOR THE HEWLETT PACKARD 3000 COMPUTER. D. G. Fitzsimons* and C. R. Taylor, Jr. Physics Dept., James Madison Univ., Harrisonburg, Va. 22807.

The preliminary design for interfacing a Langmuir probe and a Hewlett Packard 3000 computer is presented. The probe bias voltage and collected current are sampled simultaneously and converted to either eight or twelve binary bits. These data pairs are stored in a Motorola 6800-based microcomputer as the Langmuir probe bias voltage is swept. After this Langmuir trace is completed, the microcomputer transmits the data over a standard telephone line into a file in the time-sharing HP3000 computer.

A TECHNIQUE INVOLVING CARDINAL FUNCTIONS ON LINEARLY OR-DERED TOPOLOGICAL SPACES. Marlene E. Gewand*, Dept. of Mathematics, United States Naval Academy, Annapolis, Md. 21402 and Scott W. Williams*, Dept. of Mathematics, State University of N.Y. at Buffalo, Buffalo, N.Y. 14212.

We show a technique of defining equivalence relations on a linearly ordered topological space. Then by examining the resulting quotient spaces, we are able to determine properties of the original space.

Using this technique, we can characterize the Lindelöf degree of LOTS. We also use this technique to determine when a Lindelöf (or paracompact) LOTS will have a Lindelöf (or paracompact) product with any other Lindelof (or paracompact) space.

RADIO ASTRONOMY: A WINDOW INTO THE ACTIVE NATURE OF GALAXIES P.E. Hardee*, Astronomy Department, University of Virginia, Charlottesville, Virginia 22901.

Before the advent of radio astronomy only a small number of galaxies were known to be active. The activity was manifested by a peculiar overall appearance or by the presence of unusual emission features. Galaxies appeared to be quiescent, slowly evolving, self-gravitating collections of stars and gas. With the development of modern radio astronomy, i.e., single dish telescopes with large surface area and high sensitivity and multiple element radio interferometers with high resolution, the perception of galaxies began to change.

Radio surveys of the sky revealed the existence of powerful radio sources. These radio sources usually had double structure with a galaxy between the two radio lobes. The separation between the lobes was as much as 1000 times the size of the optical galaxy. Radio sources not associated with known galaxies led to the discovery of quasars. Several different types of radio source associated with active galaxies are now known. Compact sources coincident with galactic nuclei and quasars sometimes are variable with timescales of less than a month. The appearance of some radio sources suggests that jets of material can be ejected from the nucleus of a galaxy or quasar. It is thought that these objects can be powered by the infall of material in an accretion disk into a massive black hole at the center of a galaxy or quasar.

ULTRA HIGH RESOLUTION TUNABLE DIODE LASER SPECTROSCOPY OF FREON-12 FROM 1150 CM^{-1} TO 1172 CM^{-1}. C. N. Harward*, Physics Dept. of Old Dominion Univ., Norfolk, VA 23508, J. M. Hoell*, and C. H. Bair*, Langley Res. Ctr. NASA, Hampton, VA 23665

Ultra high resolution spectra of the Q-branch of Freon-12 (CCl_2F_2) have been obtained using tunable diode laser spectroscopy. Continuous spectra are presented from 1150 cm^{-1} to 1172 cm^{-1} with a spectral resolution $\leq$ .001 cm^{-1}. Absolute wavelength calibration was obtained using the SO_2 spectra as a standard and a 5 cm Ge etalon for relative calibration between SO_2 lines. The relative accuracy of the Freon-12 line positions was $\leq$ .0001 cm^{-1}. The Freon-12 data, obtained at a pressure of 10^{-3} torr, exhibited a rich and highly structured spectra. However, with the exception of two isolated features within the 22 cm^{-1} studied here, collisional broadening reduces the spectra to a structure-less continuum for nitrogen pressures greater than 20 torr. These two features continue to exhibit structure at atmospheric pressure. These results are significant for remote atmospheric measurements of Freon-12. (Aided by NASA grant 1466).

FLOW DIAGNOSTICS IN UF$_6$. I. ION AND PARTICLE PRODUCTION BY LASER-INDUCED ELECTRICAL BREAKDOWN. II. RAYLEIGH SCATTERING OF LASER LIGHT. P. A. Hoisington* and S. S. Fisher, School of Engineering and Applied Science, University of Virginia, Charlottesville, Va. 22901.

Methods are being developed to measure densities and velocities in flowing UF$_6$ gas. Apparatus has been developed to study the production of ions and particles when a pulsed nitrogen laser is focused in the gas and causes electrical breakdown. Ion production as a function of gas pressure and laser power has been measured, and ion lifetimes have been determined. Only an approximate characterization of particle formation in this process has been obtained. These particles result from photo-dissociation of UF$_6$ molecules followed by polymerization of non-volatile fragments. These ions and particles are of interest as potential flow tracers. Rayleigh scattering of photons from an Ar-ion laser beam by UF$_6$ molecules has also been examined. Initial data indicate that this scattering provides a sensitive basis for remote density sensing.

THE COMPUTER AND LEARNING PHYSICS: A STUDENT'S READOUT. S. L. HUTTON[a] Dept. of Physics,Univ. of Richmond, VA. 23173.

As a junior physics major at a liberal arts school which does not yet use the computer as a pedagogical tool on an appreciable scale, I am essentially self-acquainted with some of its potentials in that context. Initial contact with the machine through games builds confidence, plotting modes are useful as would be more sophisticated graphics for visualizing results of theory, and statistical analyses of laboratory data can be used to extract more than just the "right answer". These roles are limited to the realm beyond the classroom, but computer accessibility in the science center enhances the degree to which they can support and expand traditional course approaches. They may also reduce direct demands upon the professor. Extensive training of the student in a "computer science" oriented curriculum is not essential to his fruitful use of the computer as a learning tool.

DIFFRACTION PATTERN OF NACL CRYSTAL BY A DENTAL
X-RAY MACHINE OF WYTHEVILLE COMMUNITY COLLEGE.
D. L. Treat*, Y. P. Hwu. Physics Dept., Wythe-
ville Community College, Wytheville, VA 24382.
     In order to study the diffraction effect of a
crystal by x-ray, we have been using a dental
x-ray machine of the college. It proved to be
successful. We think it is money-saving. We
wish to thank Mrs. Joanne D. Mitchell for giving
us permission to use the machine.

FERMAT PRINCIPLE FOR AN ELLIPTICAL SURFACE.
K. Naderi*, Y. P. Hwu. Physics Dept., Wytheville
Community College, Wytheville, VA 24382.
     Laser light reflected from an elliptical sur-
face has been studied theoretically and experi-
mentally. The optical path could be maximum,
minimum, and constant.

MATHEMATICAL PATTERN OF THE BEAT OF TWO GRATINGS.
D. Hwu*, Y. P. Hwu. Physics Dept., Wytheville
Community College, Wytheville, VA 24382.
     Mathematical pattern of the "beat" of two
given gratings has been studied and also worked
experimentally:

STANDING WAVE BY THE SPRING ON A CENTRIFUGAL
MACHINE. N. Shaver*, Y. P. Hwu. Physics Dept.,
Wytheville Community College, Wytheville, VA 24382
     When a centrifugal machine rotates up to a
certain speed, a standing wave pattern has been
observed and studied.

THIRD DERIVATIVE AND CONCAVITY. Will Patterson*,
L. T. Liddle, Y. P. Hwu. Physics Dept., Wythe-
ville Community College, Wytheville, VA 24382.
     The relation between concavity and third deriv-
ative of a curve has been studied and an example
will be given.

HAND-ON HOLOGRAPHY SHOW. P. Bowman*, Y. P. Hwu.
Physics Dept., Wytheville Community College,
Wytheville, VA 24382.
     A hand-on holography show has been given to
some high school students. The result proved to
be encouraging and interesting.

A FEW DEMONSTRATIONS IN GENERAL PHYSICS.
A. Aghajan*, T. Horton*, S. Nichols*, Y. P. Hwu.
Physics Dept., Wytheville Community College,
Wytheville, VA 24382.
     Twin Newton's Ring; Diffraction Pattern of A
Blood Cell and others will be demonstrated.

EXPERIMENTAL ELECTRON ENERGY DISTRIBUTIONS IN MULTIDIPOLE
ARGON AND HYDROGEN PLASMAS. M. A. Kessel* and G. R. Taylor.
Physics Dept., James Madison Univ., Harrisonburg, Va. 22807.
     Evaluations of the experimental electron energy distribu-
tions in multidipole argon and hydrogen plasmas at high and
low neutral pressures are presented. Results are compared
with Maxwellian distributions of the same average energy
and with plasma parameters obtained by the usual Langmuir
probe characteristic analysis. Within experimental error
the distributions are found to be Maxwellian except at high
neutral pressures of 5×10^{-3} Torr, where small deviations
from Maxwellian behavior are observed.

TRANSIENT BEHAVIOR IN GAS BREAKDOWN. J. Littell* Old
Dominion University, Norfolk, VA 23508, and J. W. Wilson,
NASA Langley Research Center, Hampton, VA 23665
     There is considerable interest in the transient break-
down of gases in connection with the development of gas
lasers. This is especially true in the development of
nuclear-pumped gas lasers for which transient electrical
discharge pumping is used to "simulate" the nuclear-induced
plasma. In order to interpret such simulated results, the
properties of the transient electrical discharge generated
plasma must be known.
     Results from the study of transient breakdown in
helium gas and gas mixtures using a time-dependent Townsend
model will be presented. The role of background ionizing
radiation will be discussed along with space charge effects.
The breakdown of helium gas is strongly dependent on the
impurity level of Penning type gases for which Penning
ionization and photoelectric ionization are possible. The
rapid breakdown in long discharge tubes is achieved by
Penning and photo-ionization. Numerical examples will be
given.

THE USE OF FUNCTION SPACES TO STUDY TOPOLOGICAL PROPERTIES.
R.A. McCoy*. Dept. of Math., Va. Polytechnic Inst. and
State Univ., Blacksburg, Va. 24061
     A technique is examined in the use of spaces of continu-
ous functions for the study of topological properties of
spaces. The general kind of problem illustrated here is
that of finding topological properties P and Q such that
a space has property P if and only if $C(X)$ has property Q,
where $C(X)$ is the space of continuous real-valued functions
on X under some given topology - such as the compact-open
topology.

THE THREE THOUSAND FACES OF A HEXAGON. T.Bruce
McLean*. Department of Mathematics and Computer
Science, James Madison University, Harrisonburg,
Virginia 22807
     While attending graduate school at Princeton
University in 1939, Arthur H. Stone creased a
Mobius Band with three half twists into a flexible
hexagon. Using a technique called a pinch flex,
the paper model will produce three different
faces. By doubling the length of the band, Stone
created the first six faced flexagon and Bryant
Tuckerman provided the traverse. Richard Feynman
and John Tukey joined Stone and Tuckerman on the
first flexagon committee and Louis Tuckerman added
to the later work. In 1957, C.O.Oakley and R.J.
Wisner finished the work with some assistance by
Henry Gould. Martin Gardner supplied the history
in a 1956 Scientific American article.
     In this paper, a second way to flex the six
faced flexagon of Stone is presented. The Oakley
and Wisner paper is used to count the three
thousand four hundred and twenty faces that are
now possible and provide the traverse for these
new faces.
     Valuable insight to the final solution was
provided by high school students Alan Moluf and
Robert Verrey in 1965. In their honor, we refer to
this new technique as a V-flex.

ELECTRICAL POTENTIALS AND FIELD COMPONENTS DUE TO A CHARGED SMOKE PLUME. Alex P. Perdian* and G. E. Copeland, Physics Dept., Old Dominion University, Norfolk, VA 23508

Electrical potentials at over $8.0 \times 10^{+4}$ grid points have been obtained from an iterated numerical solution to Poisson's equation $\nabla^2 \phi = -\rho(xyz)/\varepsilon_0$. The source term $\rho(xyz)$ is obtained from the Gaussian like pollutant concentrations that result from solutions to the Pasquall-Gifford diffusion problem. Solutions for $\phi = \phi$ (xyz) are obtained for several meteorological stability classes (conditions), pollutant source emissions, and all eddy diffusion coefficients σ_y and σ_z. Cross wind and vertical electric intensity components (E_y and F_z) are obtained via numerical differentiation. An attempt is made to relate the functional forms of $E_z = E_z$ (yx) to the known behavior of the σ_y and σ_z so that remote sensing of atmospheric fields may be used to distinguish diffusion characteristics of charged smoke plumes.

PROSPECTS FOR TOKAMAK HYBRID REACTORS. W. G. Pettus, Babcock & Wilcox Co., Lynchburg Research Center, Lynchburg, Va. 24505

In the past few years there has been renewed interest in fusion-fission hybrid reactors for central station power production, fissile fuel enrichment, and other applications. The various proposed reactor concepts are reviewed briefly here and the prospects for tokamak hybrids in particular are discussed.

In these systems the plasma serves as a high energy neutron source which drives a subcritical blanket of fissile/fertile material. Several different fusion reactions are considered including D-T, D-D, and catalyzed D-D. A few of the most promising blanket concepts are described and the potential contribution of these systems to the national energy program is indicated. Safety, environmental, and nonproliferation concerns are also discussed.

AN APPROXIMATION TECHNIQUE IN UNIFORM SPACES. M. D. Rice. Dept. of Mathematics, George Mason University, Fairfax, VA 22030

The basic technique mentioned in the title is the approximation of uniformly continuous mappings by Lipschitz mappings. In particular, one can establish that each bounded real-valued uniformly continuous mapping on a metric space may be uniformly approximated by a Lipschitz mapping defined on any containing metric space. The Katětov extension theorem can be immediately derived as a corollary. The preceding result may be used to establish that each Hilbert space valued uniformly continuous mapping defined on a convex set K in a Banach space can be uniformly approximated by a Lipschitz mapping on K. From this result, one deduces that for every uniformly continuous mapping $f: K \rightarrow K$ and every $\varepsilon > 0$ (where K is a closed convex set in a Hilbert space), there exists x in K and $\lambda > 0$ such that $|f(x) - \lambda x| < \varepsilon$. The preceding results will also be related to the characterization of the subsets of the real line which allow the unrestricted extension of real-valued uniformly continuous mappings and to the discussion of the analogous property in the plane.

A DETERMINANTAL PROPERTY OF AUXILIARY MATRICES. Rana P. Singh, Department of Mathematics, Virginia State College, Petersburg, Virginia 23803

Let $I^{(k,m)}$ denotes an auxiliary matrix obtained by rearranging the columns of $I:m \times m$ by taking every k-th column starting with the first, then every k-th column starting with the second, etc., where k divides m. Then

Theorem 1. Det $I^{(k,m)} = +1$ if $\dfrac{m(m-k)(k-1)}{4k}$ is even

$= -1$ if $\dfrac{m(m-k)(k-1)}{4k}$ is odd.

The auxiliary matrices preserve the dimension and the number of 1's and 0's of the basic identity matrix.

EARLY MAYAN ASTRONOMY. Charles D. Smith and Paul H. Knappenberger, Jr. Science Museum of Virginia, 2500 W. Broad Street, Richmond, VA 23220.

The Mayans were one of the most advanced civilizations in Pre-Columbian America. They developed a knowledge of astronomy which enabled them to make accurate predictions of the motions and positions of celestial bodies. This knowledge permeated Mayan culture, influencing religious beliefs, agriculture, architecture, the calendar, and many other aspects of the civilization. This paper will review the role and degree of development of Mayan astronomy. Examples from major archaeological sites such as Uxmal, Palenque, and Chichen Itza will be shown.

TECHNIQUES FOR CONSTRUCTING VARIOUS REFINEMENTS OF POINT FINITE COVERS. J.C. Smith*, Dept. of Mathematics, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Several techniques are discussed for obtaining various types of refinements of point finite and generalized point finite open covers of topological spaces. Characterizations of various topological properties are then obtained as applications of these results.

MAGNETIC MONOPOLES - WHERE THEY ARE NOT AND
W. Peter Trower, Virginia Polytechnic Institute and
State University, Blacksburg, VA 24061.
The symbotic relationship between electricity and magne-
tism lacks the full measure of equality in that an isolated
magnetic charge has never been seen while electric counter-
parts abound in abundance. Theoretical desires for magnetic
monopoles, which are motivated by world views ranging from
purely technical to Olympian, are numerous and growing. In
spite of this demand the diligent and inventive experimental-
ist has yet to discover any phenomenon which requires for
its unequivocable elucidation the existence of this putative
particle. Here we review the history, enumerate the motiva-
tions, examine the evidence, and speculate on the future
prospects for this Unicorn of particle physics.

LETTERS FROM THE R.L. MOORE COLLECTION. Lucille
Whyburn, Department of Mathematics, University of
Virginia, Charlottesville, Va. 22903
R.L. Moore was the founder of Poin-set Topolo-
gy in the United States. He left his papers to
the University of Texas where he carried on
an active graduate program even after the usual
retirement age. The University has assembled
these papers in the MOORE COLLECTION of their
Humanities Research Center where they are
available to scholars. This paper presents a
sampling of the many interesting letters in
the R.L. MOORE COLLECTION.

MODELING OF A SOLAR-PUMPED IODINE LASER. J. W. Wilson,
NASA Langley Research Ctr., Hampton, VA 23665; J. H. Lee,*
Vanderbilt University, Nashville, TN 37235
The direct conversion in space of solar radiation into
laser radiation for power transmission to Earth, satellites,
or deep space probes shows promise as a reasonably simple
technology and may have cost advantage in deployment and
greater reliability compared to other methods of space power
generation. The main candidates for solar pumping are the
gas dynamic, photochemical, and direct photoexcited lasers.
We consider here the photochemical reaction of alkyl iodides
which predominantly excites the $I(^2P_{1/2})$ state which lases
at 1.315 μm. The iodine ground state is eventually lost
to reconstituting the gas or in the formation of molecular
iodine. The rates at which the gas is required to be
recycled through the laser system are modest. The side
exposure at 100 fold solar concentration of a 100 m long
tube with a 3 m by 30 cm cross section is estimated to
provide up to 20 kW of continuous laser output. Scaling
laws and optimum operating conditions of this system will
be discussed.

*This work was supported in part by NASA grant, NSG-1235.

ANALYSIS OF SPECTROSCOPIC PLATES. John H. Wise,
Dept. of Chemistry, Washington and Lee University,
Lexington, Virginia 24450.
The Argonne 9.15 m Paschen-Runge spectrograph
produces an abundance of high resolution spectro-
scopic plates which require analysis. A Gaertner
comparator has been interfaced with the SIGMA V
computer in the Chemistry Division, making use of
a linear encoder and a high speed DVM. A set of
computer programs has been developed for the
analysis, and these may be subdivided into several
groups: assembler language programs to handle
data acquisition (originally devised by John Hines
at Argonne), and FORTRAN programs for comparator
analysis, for data treatment, for graphics display,
and for disc file output. The most significant
program is for peak finding. The procedure in-
volves a search for a string of negative second
derivatives, with the peak chosen at the center of
the string. Program results are: peak position,
peak width, peak shape code, and a measure of peak
intensity. Operation of the comparator, the in-
teraction of the programs and some typical applica-
tions will be described.

(Work done at Argonne National Laboratory, Argonne,
Illinois.)

Biology

Fifty-seventh Annual Meeting of the Virginia Academy of Science
May 8-11, 1979, University of Richmond

SEROLOGIC AND ELECTROPHORETIC ANALYSES OF VARIOUS ORGAN EXTRACTS OF THE AMERICAN DOG TICK, DERMACENTOR VARIABILIS (SAY). S. B. Ackerman, Mary C. Floyd*, and T. W. McGill*. Department of Biological Sciences. Old Dominion Univ., Norfolk, VA 23508.
Soluble extracts of individually excised ovaries, salivary glands, midguts, and foveal glands, and an extract of adult ticks were prepared from the American Dog Tick Dermacentor variabilis (Say). Protein compositions of these extracts were analyzed by 7% polyacrylamide gel (PAGE) and 3.5%, 4.75%, 7%, and 12% gradient polyacrylamide gel (G-PAGE) electrophoresis. Antiserum to whole tick extracts were generated in a rabbit and used to compare antigenic compositions of these organs using immunodiffusion (ID) and immunoelectrophoresis (IEP). A list of the extracts and total number of protein bands delineated by PAGE (and G-PAGE when performed) includes: whole tick, 9(20); salivary glands, 12(12); midguts, 4(6); ovary, 11; and foveal glands, (4). Electrophoretic mobility patterns of these extracts were also compared to erythrocyte extracts of several species of hosts and solubilized tick fecal material. Serological analyses indicated that common and organ-specific antigens were present in each of the organ extracts, but no anti-tick antibodies reacted against hosts' erythrocyte preparations. Results of this study will be compared to investigations performed concurrently into the efficacy of some of these extracts as anti-tick vaccine antigens.

THE EFFECT OF STREAM SIZE ON POTAMOPLANKTON COMMUNITIES, Michael L. Bass, Mary Washington College, and James T. Maughan*, Metcalf and Eddy
Basic physical and chemical parameters and plankton samples were taken in riffle and pool areas on Sinking Creek at Newport, Virginia in Giles County and above and below Claytor Lake on the New River. There was no significant difference in plankton population density between the riffle and pool at any site. The plankton population density was significantly higher below Claytor Lake than above and higher above Claytor Lake than in Sinking Creek. The Wilhm and Dorris diversity index, d, for the plankton population was higher in Sinking Creek than either station in the New River. The d value for the riffle areas above and below Claytor Lake were the same. The d value for the pool areas above and below Claytor Lake were the same and lower than the d values for the riffle areas at these stations.

THE OCCURRENCE OF AQUATIC INSECTS IN BIG CEDAR CREEK, RUSSELL COUNTY, VIRGINIA, Michael L. Bass and Robert H. Strickler, Department of Biology, Mary Washington College
The purpose of this study was to describe the macro-benthic fauna of Big Cedar Creek in the area being used as a trout fishery by the Big Cedar Sportsman's Association. Emphasis was put on the aquatic insect community because it is an important source of food for trout and an excellent indicator of stream quality. Field sampling was quantitative, using a Surber type sampler and qualitative, using a D-frame kick net sampler. Forty-four different aquatic insect species representing seven insect orders (Coleoptera, Diptera, Ephemeroptera, Megaloptera, Odonata, Plecoptera, Trichoptera) and five other types of macroinvertebrates were found. The substrate character, streamside cover and water quality parameters along with the macrobenthos indicate that Big Cedar Creek should be an excellent trout growth stream. Monitoring of stream quality is continuing.

NOTES ON NAEGLERIA SPP. AND THE SOILS FROM WHICH THEY ARE CULTURED. Barbara L. Berrent and William H. Yongue, Jr, Department of Biology, V.P.I.&S.U., Blacksburg, VA. 24061
Deaths due to primary amebic meningoencephalitis have been reported in the Richmond area since 1951. The cause of this fatal disease has been recognized as a species of Naegleria, more specifically N. fowleri. At Virginia Tech, experiments are being conducted on soil samples obtained from seven lakes in the vicinity of Richmond. Our major concern was the numbers of thermophilic (46 C) amoebae that may be found in soil samples, presumably in encysted form. Primary cultures were made from each sample, grown for 48 hours, then serially diluted three times and used to inoculate cornmealagar petri dishes. Counts were made following a three day incubation period (at 46 C). The results range from >300 amoebae per field (40x) in Salisbury Lake to <10 per field in Lake Anna Cooling Lagoon. Also noted in Overhill Lake and Fall Creek was variation in the size of amoebae. The cysts and active amoebae in the seven soils ranged from 7-10 μm; however, in the two lakes, some active amoebae were two and three times larger than the average size. An explanation for this occurrence might be the co-existence of two species. Pathogenicity was not studied in this project. These results support the suggestion that several types of thermophilic amoebae may be characteristic of soils.   (Supported by V.P.I. & S.U. Small Projects Grant Program and The Center for Environmental Studies)

EUGLENA GRACILIS: TEMPERATURE AND LD 50. W. Burton Black-
burn, William H. Yongue, Jr., and John Cairns, Jr. Dept.
of Biology, V.P.I. & S,U., Blacksburg, VA 24061
    Euglena gracilis was cultured in soil extract medium and
subjected to thermal shock in intervals of 2° from an
ambient temperature of 24C to 44C. Temperature shock at
approximately 31C was found to 50% of the individuals
observed and 100% of the individuals were dead at tempera-
tures of 42C or greater. The degree of morphological
changes seemed to be proportional to the degree of thermal
shock. Euglena gracilis cultured in pond water was subject-
ed to temperature shock at selected temperatures and was
found to be more resistant to thermal shock than those
cultured in soil extract. This tends to suggest that
nutrient level may be a factor in sensitivity to thermal
shock. This work is being continued,(Supported by V.P.I. &
S.U. Water Resources Research Center and the Center for
Environmental Studies)

OCCURRENCE OF CYTOTODDIA (=TODDIA:PROTOZOA:SPOROZOA) IN
NERODIA (=NATRIX)SIPEDON (NORTHERN WATER SNAKE) FROM AN
AREA IN SOUTHWESTERN VIRGINIA. Katherine A. Booker and
William H. Yongue, Jr. Dept. of Biology, V.P.I. & S.U.
Blacksburg, VA 24061
    Cytotoddia is an intraerythrocytic parasite of cold
blooded vertebrates. This infection is observed under oil
immersion to be a basophilic staining body accompanied by a
crystalline mass. This mass varies in shape from host to
host.
    During the summer of 1978 thirty-six Nerodia were collect-
ed from a small area of southwestern Virginia. Of the
thirty-six Nerodia sampled for Cytotoddia, two were found to
be naturally infected.
    This is the first record of Cytotoddia in Virginia.
Previously, Cytotoddia had only been reported from Michigan
and Louisiana. The former occurred in Nerodia sipedon and
the latter in Agkistrodon piscivorus leucostoma (the
western cottonmouth or water moccasin). A description of
the Virginia habitat is given.

A COMPARATIVE STUDY OF CELLULAR ADHESIVENESS IN
CULTURED HUMAN NORMAL, CYSTIC FIBROSIS, AND HUNT-
INGTON'S DISEASE FIBROBLASTS. G.L. Bumgardner*,
D. Fisher*, and L.L. Wiseman. Biology Dept., Col.
of William and Mary, Williamsburg, VA 23185
    The investigation of cell surface molecules
involved in vertebrate cellular adhesiveness might
be facilitated by finding "adhesive mutants." We
chose to study two mutant fibroblast lines, cystic
fibrosis and Huntington's Disease, which, from the
literature, we suspected might show adhesive
differences when compared to normal cells (all
cells from The Human Genetic Mutant Cell Reposi-
tory in Camden, NJ). Cystic fibrosis cells
exhibited rates of rotation-mediated in vitro
cell aggregation and rates of sticking to plastic
similar to normal. Huntington's cells stuck to
plastic as did normal and did not sort out from
normal cells in mixed heterotypic aggregates.
However, Huntington's cells appeared to aggregate
somewhat faster than normal cells, forming larger
cellular aggregations after ten to twelve hours of
rotation culture. We are currently studying the
effect of glucosamine on Huntington's Disease
cellular aggregation (cell adhesion) because it
has been reported that this molecule may affect
the morphology and ability of Huntington's cells
to stick to plastic in minimal medium.

INTRANASAL IMMUNIZATION OF MICE AGAINST NAEGLERIA FOWLERI.
L.E. Bush, A.J. Seidenberg and D.T. John. Depts. Biol. and
Microbiol., Va. Commonwealth Univ., Richmond, VA 23298.
    There is little information on the alteration of the
outcome of Naegleria fowleri infections by immunotherapy.
Accordingly, we have evaluated the capability of various
intranasal (I.N.) immunization procedures to evoke increased
resistance to challenge with lethal doses of live N. fowleri.
Male DUB/ICR mice weighing 13-18g were used in all experi-
ments. Mice were immunized and challenged I.N. and deaths
were recorded for 21 days after challenge and percent protec-
tion calculated. Mouse mortality from various N. fowleri
strains ranged from 0 to 100%. Strains of high-, medium-
and low-virulence (WM, LEE & CJ, respectively) were used to
immunize three groups of mice. WM produced the best protec-
tion (77%); however, 67% of the mice died before challenge.
CJ afforded no protection, and LEE produced 72% protection
with only 17% of the mice dying before challenge. LEE
strain was used to immunize mice 1, 2, 3 or 4 times with
doses ranging from 10^2 to 10^5 amebae/mouse. Mice that had
been immunized 3 times with 10^3 amebae/mouse exhibited the
best protection (56%) against lethal challenge. Again, LEE
was used to immunize mice that were challenged either 1 or 2
weeks after immunization. Mice challenged 2 weeks after im-
munization showed consistently greater protection. N. gru-
beri, a nonpathogen, was used to immunize mice either 1, 2,
3 or 4 times. Mice that had been immunized 3 times exhibi-
ted the best protection (88%).

POPULATION DYNAMICS AND CONTROL STRATEGIES FOR FREE-RANGING
BURROS: A MODELLING APPROACH. Mark T. Butt*, Alan R.
Tipton* and Patrick F. Scanlon, Dept. Fisheries and Wildlife
Sciences, Va. Polytech. Inst. and State Univ., Blacksburg,
Va. 24061
    A literature search was used to generate data on repro-
ductive success and longevity of feral burros (Equus asinus).
Using a modified Leslie matrix seven possible population
age structures were generated. Of these, the simulation
using 0.57 foals/female/year and a standard mortality
produced results comparable to published material on
domestic burro reproduction and observations on feral
animals. From a stable age structure with 1413 females,
five control methods were evaluated: 1) reduction of
natality by exogenous drugs, 2) % cropping of adults,
3) % cropping of young, 4) predetermined cropping of all
ages, and 5) % cropping of all ages. A 20% cropping of
immature burros for five years reduced the population from
1413 to 1130, a 20% decrease. Although other methods
produced greater reductions, this method is considered the
most useful approach for managing burros for the following
reasons: population structure is not radically altered; a
significant reduction of animals is imposed; young animals
are more vulnerable; the control could be carried out with
limited funds and knowledge of the population to be con-
trolled.

EFFECT OF MATERNAL AUTOIMMUNITY ON REPRODUCTIVE SUCCESS AND
THE INCIDENCE OF ANEUPLOID OFFSPRING IN MICE. Carolyn M.
Conway and Arthur F. Conway, Depts. of Biology and Anatomy,
Va. Commonwealth Univ., Richmond, Va. 23284
    The effect of specific and non-specific immune stimula-
tion on reproductive success (e.g., litter size, neonatal
survival) and the incidence of aneuploid and mosaic off-
spring was studied in CD-1 mice. Autoimmune thyroiditis
was induced in female mice by subcutaneous injections of
thyroid homogenate-Freund's adjuvant emulsions. Non-speci-
fic immune stimulation was achieved by subcutaneous injec-
tions of saline-Freund's adjuvant emulsions. Liver cells
from 17 day fetuses were used for chromosome analysis.
Aneuploid fetuses were found only in those females in which
autoimmune thyroiditis was induced. Mosaic fetuses were
found among the offspring of all immune stimulated females.
These results suggest a correlation between maternal auto-
immune disease and chromosomal nondisjunction during either
the meiotic divisions of oogenesis and/or the mitotic
divisions of embryogenesis. Neonates born to some females
in which autoimmune thyroiditis was induced showed signifi-
cantly reduced survival. In addition some of these neonates
exhibited the characteristic symptoms of runt disease in-
dicating that immune competent cells crossed the placenta
and affected postnatal development of the offspring.
(Supported by the Grants-In-Aid Program for Faculty of
Va. Commonwealth Univ.)

INFLUENCE OF MAGNESIUM ON CADMIUM TOXICITY EFFECTS ON CELL DIVISION AND CALCIFICATION IN THE COCCOLITHOPHORID ALGA, CRICOSPHAERA CARTERAE. K. E. Corum ,* and E. F. Stillwell. Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508

Cadmium (Cd) added to normal media and to magnesium (Mg)- deficient media produced inhibitory effects on cell division and cell calcification in the coccolithophorid alga, Cricosphaera carterae . Compared with controls in normal media (25 mM Mg), cell growth decreased progressively with added Cd concentrations (1.0- 20 uM). In Mg-deficient media (6 mM and 0.08 mM Mg) the inhibitory effects were more pronounced with complete arrest of cell division at 20 uM Cd. The greatest Cd inhibition occurred in media with the lowest Mg concentration (0.08 mM). Cadmium (1.0- 20 uM) also decreased recalcification (coccolith formation) in cells previously decalcified with CO_2 with complete inhibition at 40 uM Cd. Inhibition of recalcification in various Cd concentrations (1.0 - 20 uM) was more pronounced in low-Mg media (0.08 mM) compared with normal media (25 mM Mg). Partial or complete reversal of the inhibitory effects of Cd and low Mg media on cell division and calcification occurred following a wash and resuspension of the cells in normal control media (25 mM Mg).

THE ECOLOGY OF CUTEREBRA PARASITISM IN PEROMYSCUS LEUCOPUS. Jack A. Cranford. VA Polytechnic Inst. and State Univ. Bio. Dept. Blacksburg, VA 24061

The host parasite relationship between Cuterebra fontinella and Peromyscus leucopus will be discussed as the result of intensive lab. rearing of both the parasite and its host. The mean generation time of C. fontinella is 76.8 ± 1.4 days under conditions of $20°C$ and LD 16:8. The adult flies are sexually dimorphic which results in different times in the larval as well as the pupal stages. P. leucopus maintains normal weight balance while infected but increased food consumption occurs reaching its peak just prior to the parasites emergence from the host. Among 10 other species tested for their susceptibility to parasitism Tamias striatus, Glaucomys volans, Clethrionomys gapperi, and Napeozapus insignis show no reaction to the parasite and no successful infections were noted. The results in six other species vary from partial infection to total infection resulting in death of the host. In the normal host P. leucopus some form of partial immunity results as the successful infection rate drops from 74% to 45% on the second cycle and to 37% on the third cycle.

Other projects currently under way within my laboratory will be discussed. 1. Peromyscus leucopus, Peromyscus maniculatus and Zapus hudsonius, Napeozapus insignis competitive interactions. 2. Ecology of Synaptomys cooperi in VA. 3. Maternal and Paternal contributions to offspring rearing in Microtus pennsylvanicus. 4. Zapus hibernation ecology.

OSMOTIC FRAGILITY OF RED BLOOD CELLS OF MARINE INVERTEBRATES. Robert Demanche.* Dept. of Biology, Col. of William and Mary, Williamsburg, VA 23185

The osmotic fragility of a red blood cell population is described by the percentage of cells that lyse when placed in increasingly hypotonic solutions. While osmotic fragility has been studied extensively in mammals, little information exists for red cells of invertebrates. Unlike vertebrate blood, the fluids that bathe invertebrate red cells may vary greatly in osmotic concentration, temperature and pH. The osmotic fragility of red cells of five invertebrate species, representing four phyla, were investigated, and the results compared with previous findings on mammalian red cells.

WOOD DUCK NESTING AND BROOD UTILIZATION OF AGRICULTURAL FIELD WETLANDS IN A FLOODPLAIN. R. T. Di Giulio*, School of Forestry and Wildlife, Louisiana State Univ., Baton Rouge, La. 70803

Artificial Wood Duck (Aix sponsa) nesting boxes were placed in 5 wetlands in a Louisiana floodplain which were surrounded by agricultural fields and contained no natural nesting cavities. Nesting use of the boxes and duck brood usage of these wetlands and 4 similar wetlands containing neither natural nor artificial cavities were examined.

In 1976, 5 successful Wood Duck nests were found in the boxes. In 1977, 11 successful Wood Duck nests and 4 successful Hooded Merganser (Lophodytes cucullatus) nests were observed. No ducklings were observed in agricultural field wetlands beyond the day on which they exited nest boxes. Two Wood Duck hens, presumably leading broods, were followed by radio-tracking. Both hens apparently led their broods to larger, more isolated wetlands which contained more aquatic vegetation. An absence of herbaceous vegetation was concluded to be an important factor contributing to the lack of brood usage of the agricultural field wetlands. (Aided by Louisiana Department of Wildlife and Fisheries, Louisiana Agricultural Experiment Station, and the National Skeet-shooting Association)

BIOGEOGRAPHY OF MAMMALS ON THE VIRGINIA BARRIER ISLANDS. Raymond D. Dueser and John H. Porter*, Dept. of Environmental Sciences, Univ. of Va., Charlottesville, Va. 22903

Small mammal populations were sampled on 9 Virginia barrier islands. The number of species ranges from 0 on a small, sparsely-vegetated island (Little Cobb) to 5 on a large, forested island (Parramore). Species diversity (= richness) increases directly with island area, elevation and habitat complexity. Each species occupies an optimal habitat in which it is particularly abundant. Habitat expansion (the occupation of multiple plant associations) is associated with high population density in optimal habitat. There is circumstantial evidence that competition also affects species distributions. The small mammal communities on these islands represent equilibrium conditions, with low rates of colonization and high rates of extinction interacting to produce a steep species-area curve. Intensive studies of 7 small mammal species on Assateague Island, just north of the Virginia islands, confirm that habitat selection and competition both influence species distributions on an island. Although competition is pervasive among these species, only a single species was limited in distribution primarily by competition.

VOLUME REGULATION IN AN ESTUARINE ANNELID. J.A. Dykens *. College of William and Mary, Williamsburg, Va. 23185

Upon exposure to dilute sea water, the annelid Nereis succinea swells a predictable amount. With continued exposure, the animal adjusts its volume towards the initial size by active metabolic processes that require oxygen and are retarded by cold. Ammonia excretion increases prior to and remains elevated during regulation implying an increased energy demand for this process. Ouabain inhibits this excretion, but has no effect on volume readjustment. Manipulation of the ionic composition of the media indicates that volume regulation is not heavily dependent on passive fluxes of K^+, Na^+ or Cl^-. Volume regulation is not effected by either Amiloride or Diamox. Volume readjustment does not occur if either Ca^{++} or Mg^{++} are absent.

A NEW DEVELOPMENT IN MEASURING INTRAFOLLICULAR PRESSURE IN RABBIT OVARIES PRIOR TO OVULATION. K. P. Flagge* and R. J. Swanson, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508
    Measurement of intrafollicular pressure in rabbit ovaries requires glass microneedles with bores varying in diameter from 15-25 μm for injection to 20-40 μm for pressure recording. A micropipette grinder is used to produce sharp, beveled, and smooth needles. Surgery is performed on female rabbits two to four hours postcoitus. With the ovary exposed, selected Graafian follicles are injected with normal rabbit serum (NRS) or physiological saline (PS), while simultaneously recording pressure. Pressure thus measured shows an immediate intrafollicular rise, which is sustained for several minutes in the case of NRS and for less than a minute with PS. We feel that the time difference is due to differing diffusion characteristics of the two fluids.

SOME REACTIONS OF WHITE-TAILED DEER TO XYLAZINE HYDROCHLORIDE. David F. Gibson,* Anne Oelschlaeger,* Patrick F. Scanlon, and Roy L. Kirkpatrick, Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061
    Xylazine hydrochloride (Rompun) was used in 47 attempts to immobilize adult female white-tailed deer (Odocoileus virginianus). Doses were given at the rate of 2.2 mg/kg body weight (B.W.) or on a metabolic body weight basis ($BW^{0.75}$). Administration was either by means of a blowpipe syringe or manual syringe following manual restraint. The deer were either injected during manual restraint or were injected with the blowpipe syringe after release. Data were recorded on induction times, rectal temperatures and respiration rates, at collapse and 15, 30, and 90 minutes after collapse. Mean induction times (S.D.) for the different administration methods ranged from 6.3 (4.7) to 11.7 (7.3) minutes but did not differ significantly among treatment groups. Respiration rates of immobilized deer were erratic with periods of apnea and hyperpnoea. Rectal temperatures declined significantly over time during immobilization. Recovery from immobilization was usually 2-3 hours after injection.

INFLUENCE OF FOOD RESTRICTION AND CADMIUM INGESTION ON BODY GROWTH AND ORGAN WEIGHTS OF MALLARD DUCKLINGS. Daniel C. Gray*, Patrick F. Scanlon, and Roy L. Kirkpatrick. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061
    A total of 96 mallard (Anas platyrhynchos) were assigned to either of 2 feeding levels (ad libitum or 80% ad libitum) and one of 4 Cadmium levels (0, 10, 50, or 250 μg/g Cadmium in the diet). Diets of restricted ducklings were adjusted every second day based on ingestion rates of the ad libitum fed ducklings. All ducklings were killed at 28 days and the following data recorded; sex, body weight, weights of brain, liver, and kidneys, packed cell volume (PGV) of blood, and calcium levels of bones were determined later by atomic absorption spectrophotometry. Data were analyzed by Analysis of Variance. Nutrition level had significant effects on bodyweight (P<0.0001), brain weight (P<0.0001), liver weight (P<0.0001), and kidney weight (P<0.0001). Gadmium level significantly affected body weight (P<0.0001), brain weight (P<0.001), liver weight (P<0.005), PGV (P< 0.0001), and bone calcium levels (P<0.01). There were significant interactions of cadmium x nutrition (P<0.005) on PGV and of nutriton x sex (P<0.05) or bone calcium levels.

INFLUENCE OF LEVEL OF CADMIUM INGESTION AND DIETARY RESTRICTION ON RETENTION OF CADMIUM IN TISSUES OF MALLARD DUCKLINGS. Daniel G. Gray*, Patrick F. Scanlon, and Roy L. Kirkpatrick. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061
    Gadmium levels in brains, livers, kidneys, bones, and feathers of mallard ducklings (Anas platyrhynchos) were determined by atomic absorption spectrophotometry following death at 28 days. The ducklings (N=96) were randomly assigned on Day 1 of life to one of two nutrition levels (ad libitum or 80% ad libitum) and to one of 4 cadmium levels (0, 10, 50, or 250 μg/g of feed). Analyses of variance were used to analyze data. Significant (P<0.0001) effects of cadmium level were found on cadmium levels of all tissues (brain, liver, kidney, bone, and feathers). Nutrition level significantly (P<0.05) influenced brain cadmium levels. There were significant interaction effects as follows: liver cadmium, cadmium level x nutrition level (P<0.05); kidney cadmium, cadmium level x nutrition (P<0.01); bone cadmium, nutrition x sex (P<0.01) and cadmium level x nutrition level x sex (P<0.005); feather cadmium, cadmium level x nutrition level (P<0.005), and cadmium level x nutrition level x sex (P<0.05).

INFLUENCE OF GADMIUM INGESTION AND FOOD RESTRICTION ON SELECTED BEHAVIORS OF MALLARD DUCKLINGS. Daniel G. Gray*, Patrick F. Scanlon, and Roy L. Kirkpatrick. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061
    A total of 96 mallard (Anas platyrhynchos) ducklings were randomly assigned to one of 2 nutrition levels (ad libitum and 80% ad libitum) and to one of 4 levels of cadmium (0, 10, 50, and 250 μg/g feed) on the first day after hatching. Avoidance behavior was tested on day 5 and open field behavior was tested on day 10. Avoidance behavior was tested in an apparatus which provided a frightening stimulus and automatically recorded the distance run by ducklings at 2 seconds after provision of the stimulus. Open field behavior was measured in a 60x60x30 cm box fitted with 4 pairs of photoelectric light sources and was recorded as the number of times light beams was interrupted in a 3 minute interval. Analysis of Variance tests indicated that neither nutritional level nor cadmium level significantly influenced avoidance behavior. Nutrition level significantly (P<0.05) influenced open field behavior though cadmium level did not.

THE DISTRIBUTION OF THE SOUTHEASTERN SHREW, SOREX LONGIROSTRIS, IN VIRGINIA. Carol S. Jones* and John F. Pagels. Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284
    Records were obtained of captures of the southeastern shrew, Sorex longirostris longirostris, from 29 localities in Virginia. Most of the sites are in the Piedmont and a few in the Coastal Plain. We were able to locate only three specimens from the Ridge and Valley Province. Most of the southeastern shrews taken in the State were from elevations approximating 300 ft, but one site in Page County was 1200 ft. Ecological data indicate that this shrew is largely restricted to habitats that may be variously described as old field, edge, or disturbed areas in forests. Ponds or streams are usually nearby, and the plant most often noted is Japanese honeysuckle.
    A second subspecies, the Dismal Swamp shrew, S. l. fisheri, was not considered in the present study.

TESTOSTERONE CONCENTRATIONS IN CHINCHILLAS. J. Thomas Jones*, Patrick F. Scanlon, Wanda B. Morehead* and Francis C. Gwazdauskas. Depts. of Fisheries and Wildlife Sciences, and Dairy Science, Va. Polytechnic Inst. and State Univ., Blacksburg, Va 24061.

Testosterone (T) concentrations were determined by radioimmunoassay (RIA) in blood plasma of post pubertal male chinchillas (Chinchilla laniger). A total of 22 males were used in the experiment. Each was individually housed in cages maintained at 22 C in a 14:10 light dark cycle. Blood samples were taken during each hour of the day. Each male was sampled 3 or 4 times. Males were assigned bleeding times (i.e. hours of day) and two weeks were allowed to elapse between successive bleedings of individuals. Bleedings were by heart puncture following anesthetization with methoxyflu ane. Mean T concentrations for all 85 samples assayed were 2.75 ng/ml (1.96 S.D.). The range of T values was 0.17 ng/ml to 9.25 ng/ml. T values tended to be minimal for samples taken between 1200 and 1300 hrs.

LEAD LEVELS IN MOURNING DOVES COLLECTED FROM MID-ATLANTIC STATES IN 1977. R. J. Kendall and P. F. Scanlon. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

Lead concentrations (μg/g d.w.) were determined by atomic absorption spectrophotometry in bone tissues of 236 mourning doves (Zenaida macroura) collected by hunters in 8 counties of 4 Middle Atlantic States (MD, VA, NC, and SC) as part of a monitoring project for lead contamination. Mean lead levels, [S.D.], and numbers examined in all 8 counties were as follows: Kent, MD (34.48[60.01]N=6); Queen Anne, MD (21.81[33.94]N=4); Mecklenburg, VA (18.84 [25.33]N=23); Montgomery, VA (30.59[36.60]N=36); Guilford, NC (71.87[130.88]N=54); Scotland, NC (36.77[65.13]N=61); Chesterfield, SC (81.85[156.98]N=38); and Hampton, SC (41.08 [81.68]N=14). Dove bone lead levels can reflect chronic lead ingestion thereby allowing their use as biological monitors for lead contamination in terrestrial ecosystems. It was interesting to note the relatively high lead levels detected in birds collected from Guilford ($\bar{X}$=71.87),N.C. and Chesterfield ($\bar{X}$=81.85), S.C. as compared to the other counties. Birds from the Cuilford area were associated with a high human population density probably allowing increased lead exposure. Chesterfield doves were obtained adjacent to a major highway system and possibly were ingesting lead contaminated roadside grit particles. Investigations are continuing on the characterization of lead exposure patterns in these birds.

ULTRASTRUCTURAL CHARACTERISTICS OF KIDNEY TISSUE OF RINGED TURTLE DOVES FOLLOWING LEAD INCESTION. R. J. Kendall, L. A. Weiss*, J. A. Twitty* and P. F. Scanlon. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

Ringed turtle doves (Streptopelia risoria) received 0 or 4 x 110 mg lead shot, while maintained on a corn diet, and the toxicology of lead in kidney cells was investigated. The bird receiving lead shot exhibited classical signs of lead poisoning in avians including bile stained vent, lethargy, and emaciation. Upon sacrifice at 2 weeks post-treatment, kidney tissue was obtained from both treatment and control birds and fixed in 10% buffered formalin for histological evaluation. Kidney tissue from both birds were placed in glutaraldehyde and later stained with uranyl acetate for electron microscopic examination. Ziehl-Neelsen acid fast staining revealed intranuclear inclusion bodies in the proximal convoluted tubules of the lead treated bird (100X, 400X, and 1000X). These intranuclear pinkish granules were not detected in control kidney tissue. Ultrastructural examination of these inclusions revealed these granules were in fact not clumped chromatin (8.3 x 10^3X) but had a structure consisting of a dense central core and outer fibrillary zone (33 x 10^3X). This ultrastructural study of intranuclear inclusion bodies from the same kidney in which inclusions were determined histologically demonstrates the value of histopathology for determination of lead poisoning in doves resulting from lead shot ingestion.

DEMONSTRATION OF A NEW INSTRUMENT (P.S.E.) FOR RE-SEARCH IN BIOLOGY AND MEDICINE. Michael P. Kradz* and John C. Bartone. American Health Research Institute, Annandale, Virginia 22003.

Preliminary experiments begun in 1971, continue to indicate reliability of the instrument called the Psychological Stress Evaluator (PSE) which was patented in 1976. However, reliability varies with use and training of operators. Some investigators with faulty procedures report negative results. The PSE records stress through voice analysis. Experimental control is very important in order to obtain correct laboratory results. Voice analysis requires proper preparation of person being examined. The questioning or "interrogation technique" must be also carefully designed in each particular case (person, client or suspect), to reduce extraneous factors (often ignored). Analyses of voices properly performed can not only reveal the presence of stress but also in which areas the stress exists. Causes of stress in people are multitudinal and can range from mild upset to hysterical (psychic) trauma. Stress also has an extremely high correlation with wrong-doing, guilty consciences or association with what people consider morally wrong. These factors will be presented by PSE-charts as in cases of drugs, shop-lifting, larceny, theft and assault. Various evidence provides PSE reliability.

PREGNANCY BLOCKING IN RODENTS: ADAPTIVE ADVANTAGES FOR FEMALES. J. B. LABOV*, Dept. of Biology, Washington and Lee Univ., Lexington, Va. 24450.

Recently inseminated female rodents exposed to unfamiliar males often terminate pregnancy and return to estrus. Pregnancy blocking may increase male reproductive success and reduce the chance of providing parental investment to unrelated offspring. The adaptive significance for females is unclear.

Pregnancy blocking was studied for possible female advantages. Two hypotheses were tested: 1) Females exposed to socially dominant males will lose pregnancies more often than those exposed to subordinates. Females invest much time and energy in pregnancy, and those which encounter dominant (presumably fit) males may increase their ultimate reproductive success by terminating the pregnancy and remating. 2) Males which are unable to terminate a pregnancy sired by a competitor may kill unrelated offspring and reinseminate the female. Pregnancy blocking may be a female counter-response to male infanticidal behavior.

Experiments with house mice (Mus musculus) showed no differences in pregnancy blocking ability of dominant and subordinate males. However, males killed significantly more unrelated than related offspring. The data are interpreted in terms of female energetics, lifespan, and population social structure. Data in the literature for other mammals and one species of bird are reinterpreted from the perspective of female advantage.

AN ATTEMPT TO ISOLATE INHIBIN FROM OVINE TESTICULAR TISSUE. B. D. LaMar* and R. J. Swanson, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508

In an attempt to isolate inhibin from testicular tissue, a supernatant of freshly frozen ovine testicles was prepared through centrifugation. This supernatant, processed through a Concanavalin A/Sepharose column, yielded three proteinaceous fractions: (1) non-binding proteins, (2) binding non-glycoproteins, and (3) glyco-proteins. Using maturing rats, FSH suppression by these fractions will be tested in a bioassay developed in our laboratory.

LEAD CONCENTRATIONS IN PINE VOLES TRAPPED FROM TWO VIRGINIA ORCHARDS. Robert L. Lochmiller II, Ronald J. Kendall, Patrick F. Scanlon, and Roy L. Kirkpatrick. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va 24061.

Pine vole *(Microtus pinetorum)* carcasses were analyzed for lead concentrations. The carcasses were from 105 pine voles which were trapped from 2 orchards, one abandoned (A) and one maintained (M), during 2 months - January and November. Livers and gastrointestinal tracts were removed for other studies. Pine voles were classified by age into juveniles (<7 weeks), subadults (7-10 weeks), and adults (>10 weeks). Mean ($\pm$S.E.) levels of lead (μg/g,d.w.) for all voles (by orchard and by month) were as follows: 31.12 ± 2.77 (A, Jan.); 20.48 ± 2.31(A, Nov.); 25.71 ± 2.04 (M, Jan.); and 24.74 ± 3.22 (M, Nov.). Analysis of variance indicated that there were significant effects of month of collection ($P<0.05$) and age of pine voles ($P<0.001$) on lead levels of pine voles. There was a significant ($P<0.05$) interaction between effects of orchard and month of collection on lead levels.

DIGESTIBILITY OF APPLE, FORB AND LABORATORY CHOW DIETS BY MICROTUS PINETORUM. R. L. Lochmiller*, R. L. Kirkpatrick, and J. B. Whelan*. Dept. of Fisheries and Wildlife Sciences, Va. Polytech. Inst. and State Univ., Blacksburg, Va. 24061.

Twenty-one adult pine voles (Microtus pinetorum) were live trapped from orchard habitats in southwest Va. and separated into 3 groups of 7 animals each. Each group was placed on a diet of either apple fruit (pulp only), dandelion leaves (Taraxacum officinale), or Purina Laboratory Mouse Chow. Apples and forbs were collected during the month of August and given fresh during the trial. Animals fed a diet of Purina Lab Chow served as the control to which the other diets could be compared. The lignin tracer technique of determining diet digestibility was employed in this study. Lignin concentrations were determined utilizing the permanganate lignin procedure.

Animals on a dandelion diet lost an average of 2 grams, while those on an apple diet lost an average 2.5 grams in body weight during the 5 day digestion trial. Animals on the lab chow diet maintained a constant body weight and in some cases increased in weight. Apple pulp had the highest digestibility coefficient for both dry matter (92.0% + 0.7) ($\bar{X}$ + S.E.) and energy (90% + 1.7). Dandelion had digestion coefficients of 64.4% + 9.8 for dry matter and 59.7% + 7.9 for energy. Lah chow was determined to have digestion coefficients of 68.0% + 1.9 for dry matter and 73.4% + 1.1 for energy.

SUMMER FOOD PREFERENCES OF MICROTUS PINETORUM AS DETER-MINED BY LABORATORY CHOICE TESTS. R. L. Lochmiller*, R. L. Kirkpatrick, and J. B. Whelan*. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

The food preferences of Microtus pinetorum were studied during May, 1978 to estimate the potential food supply available to them in apple orchard habitats in southwest Va. Food preferences of voles caught in apple orchards were studied using "cafeteria choice tests" under laboratory conditions. Animals were offered a choice of several freshly clipped foods twice daily. The quantity of each food consumed was determined and then each food item was assigned a preference rank.

Apple fruit was preferred over all other food items (14 items) tested. Among the 10 species of forbs tested, dandelion (Taraxacum officinale) appeared to be most prefer-ed, however, the degree of preference of this species was only slightly greater than that of broad-leaved plantain (Plantago major) and clover (Trifolium sp.). Of all forages tested, grass species tended to be the least preferred. Of the 2 species of grasses tested, Muhlenberg grass (Muhlen-bergia schreberi) was preferred over orchard grass (Dactylis glomerata). When the degree of consumption of forbs was compared to that of grasses, forb species, on the average, comprised 87% of the total diet while grasses made up 13%.

Overall, pine voles appeared to be quite diverse in their feeding habits.

SEASONAL VARIATIONS IN FOOD AVAILABILITY FOR TWO MICROTUS PINETORUM POPULATIONS FROM SOUTHWEST VIRGINIA APPLE ORCHARDS. R. L. Lochmiller*, R. L. Kirkpatrick, and J. B. Whelan*. Dept. of Fisheries and Wildlife Sciences, Va. Poly-tech. Insr. and State Univ., Blacksburg, VA 24061.

Seasonal biomass and energy production of forages avail-able to Microtus pinetorum populations were measured in a maintained and an abandoned apple orchard. A 100% clip of live vegetation was made on 24 ($1m^2$) sample plots (12/or-chard) for each of the seasons sampled. Apple production was measured by 10 ($1m^2$) soft mast traps in each orchard. Dry matter (DM) and energy (GE) production was determined for each season and orchard.

Production estimates of preferred forages in the main-tained orchard were 135.2, 130.9 and 47.3 g/m^2 of DM and 583.6, 580.8 and 223.7 kcal/m^2 of GE for the summer, fall and winter, respectively. Production estimates in the abandoned orchard were 24.8, 38.9 and 8.3 g/m^2 of DM and 108.8, 165.7 and 38.5 kcal/m^2 of GE for the summer, fall and winter, respectively. Annual apple production was determined to be 205.6 and 127.2 g/m^2 of DM and 895.1 and 552.5 kcal/m^2 of GE in the maintained and abandoned orchard, respectively. It was concluded that apple production provided and important energy reservoir for sustaining large pine vole populations through the winter.

THE EFFECT OF THE SOCIAL ENVIRONMENT ON SEXUAL MATURATION OF FEMALE DEERMICE (PEROMYSCUS MANICULATUS BAIRDI). Dònna L. Lombardo and C. Richard Terman. Biology Dept., College of William and Mary, Williamsburg, VA 23185.

Female deermice were housed from weaning as isolates; with one or five adult males or females; or with groups of five adult males plus five adult females. After 14 days, body, uterine, ovarian and adrenal weights were determined. Body weights of females reared with five males were significantly greater than those of females from the other treatments except for those reared with one male. Females reared with five or more adults of either sex had significantly smaller uteri than paired or isolated females. The ovaries of females reared with grouped adults were likewise smaller in size than those maintained alone or with single animals of either sex, although not at the same level of significance. No clearly defined inhibition or stimulation of sexual maturation dependent upon sex of conspecifics was observed. The interaction of sex and number of conspecifics in regulating female sexual maturation through pheromonal and behavioral cues will be discussed.

TRACE NUTRIENTS IN LOBLOLLY PINE *(PINUS TAEDA, L.)* NEEDLES USING PROTON INDUCED X-RAY EMISSION (PIXE). E. M. Long, E. S. Wise, Christopher Newport College, Newport News, Va. 23601, and G. C. Grant, H. Aceto, Jr., College of William and Mary (Research Campus), Newport News, Va. 23606.

The trace nutrient composition of *Pinus taeda L.* needles has been determined using PIXE. Monthly litter samples were taken (Jan. 1978-Feb. 1979) from three predominantly *Pinus taeda* sites on Bladen type soil. These three sites consist of 90 yr. *P. taeda* on moderately drained soil and *P. taeda* on moderately and poorly drained soil. Techniques have been developed to investigate the nutrient content of these needles with respect to tree age (90 yr versus 9 yr), soil condition (moderate to poor drainage), season (summer versus winter) and live needle versus fallen needle. NBS SRB 1575 was analysed to check for accuracy. Elements de-termined include: P, S, Cl, K, Ca, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, and Pb.

TRACE ELEMENT AVAILABILITY IN BLADEN-TYPE SOILS, G. W. Long, E. S. Wise, Christopher Newport College, Newport News, Va. 23601. G. C. Grant and H. Aceto, Jr., Coll. of William and Mary (Research Campus) Newport News, Va. 23606.

Three standard soil extraction procedures (1) 0.005 M DTPA (diethlyenetetraminepentaacetic acid) (2) 1 M NH_4OAc and (3) 0.050 N Hcl/0.025 N H_2SO_4 were compared by analysing the extracts by Atomic Absorption Spectrophotometry and Proton Induced X-ray Emission (PIXE) to determine trace element availability in Bladen-type soils. Three sites were studied: A site with 90-year-old pines having fair drainage, another site that had been reforested, also having fair drainage, and the third site containing 9-year old pines (reforested) having poor drainage. These sites were compared on a basis of their micronutrient availabilities. A comparison was also made of the elements present in the soil itself versus the extractable elements. Different filtration procedures for the leachate were studied.

ADHESIVE INTERACTIONS OF EMBRYONIC CHICK HEART AND LIVER CELLS IN CULTURE: FIBROBLASTS, HEPATOCYTES, AND MYOCYTES ALONE AND IN COMBINATIONS. V.J. Macko[*] and L.L. Wiseman. Biology Dept., Col. of William and Mary, Williamsburg, VA 23185

The fusion, in $vitro$, of two different, small pieces of embryonic tissue generally leads to the partial or total envelopment of one tissue by the other. This behavior is probably mainly dependent upon differences in intercellular cohesiveness, with the less cohesive tissue mass coming to surround the more cohesive mass. For example, embryonic chick liver tissue usually surrounds heart tissue when the two are allowed to fuse in culture. We wondered if the tissues, which behave as discrete types in fusion experiments, might contain adhesively distinguishable subpopulations of cells. By separating suspensions of 11-day embryonic heart and liver cells into populations which stick quickly to plastic (fibroblast-like cells) and populations which do not (myocytes and hepatocytes), we were able to produce four types of "homogeneous" cellular aggregates, each of which displayed different and distinct adhesive behavior when combined with other aggregates in all six possible binary combinations. Each of these embryonic tissues seems to consist of a more (fibroblast) and a less (myocyte and hepatocyte) cohesive population of cells.

SEASONAL EFFECTS OF TEMPERATURE ON THE OXYGEN AFFINITY OF CRUSTACEAN HEMOCYANIN. N.A. Mauro[*](Intro. by C.P.Mangum). Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185

Although metabolic adaption to temperature has been investigated in decapods (Robert, 1971; Mauro, 1978), the systemic role played by hemocyanin in adapting to seasonal temperature fluctuations is not known. In this study the seasonal effects of temperature on the oxygen affinity of Callinectes sapidus hemocyanin were investigated. It was observed that the hemocyanin oxygen affinity of summer animals was higher than winter animals when tested at the same temperature of 25°C. This difference in oxygen affinity results in an increased oxygen transport by the blood which was not reversed by a three week acclimation of summer animals to winter temperatures. By comparison, winter animals are unable to adapt the oxygen affinity of their hemocyanin to winter conditions and therefore exhibit a decreased oxygen transport by their blood for that period of the year.

INFECTION OF MICE BY NAEGLERIA FOWLERI FOLLOWING INTRAVENOUS INOCULATION. R.G. May and D.T. John. Dept. Microbiol., Va. Commonwealth Univ., Richmond, VA 23298.

Investigators have concluded that the natural route of invasion for Naegleria fowleri is intranasal (I.N.). The best route for experimental infection would seem to be I.N.; unfortunately, this often is an inaccurate or inconsistent method of inoculation. To avoid using I.N. instillation, and yet obtain similar results, mice could be inoculated intravenously (I.V.). This report describes the course of N. fowleri infection in mice following I.V. inoculation. All mice were male DUB/ICR weighing 13-18g. Eight mice were inoculated I.V. with either 10^3, 10^6 or 10^7 N. fowleri. Blood was collected from 5 to 160 minutes after inoculation; results showed that amebae were cleared from the blood before 5 min, between 5-10 min, and between 120-160 min, respectively. Thirty-two mice were inoculated I.V. with 2.4×10^6 N. fowleri; at selected times after inoculation, tissues were obtained for culture and histology. Amebae were cultured and observed in H&E stained sections from brain (days 1-21), lung (days 1-12), liver and kidney (days 1-5). Infected mice showed slower weight gain, leukocytosis, reduced lymphocyte/neutrophil ratio, neurological symptoms and mortality. Histologically, the disease was characterized by amebic invasion of the brain, hemorrhage, edema, meningeal and perivascular leukocytic infiltration, and necrosis. Mice inoculated I.V. with N. fowleri died from meningoencephalitis similar to that observed for mice inoculated I.N.

SOIL LEACHATES AND CULTURING OF NAEGLERIA SPP, John D. Mitchell and William H. Yongue, Jr. Dept. of Biology, V.P. I. & S.U. Blacksburg, VA 24061

Soils from the Richmond, Virginia area were used in the preparation of media for the growth of soil amoebae using the soil leachate as the sole source of nutrients. Leachates, in agar, from seven different lakes were used to culture isolates from one of these lakes at 42.0°C. The chemical composition of each leachate was determined using a Perkon-Elmer 460 Atomic Absorption Spectrophotometer. Width of the central-most portion of an inoculation streak was used for relative growth of each culture. Preliminary results tend to suggest a relationship between high magnesium ion concentration and good growth of amoebae. Research is being continued to determine the effects of increasing magnesium ion concentration of leachates on the extent of growth of thermophilic soil amoebae. (Supported by V.P.I. & S.U. Small Projects Grant Program and The Center for Environmental Studies)

EUGLENA, TEMPERATURE AND CHROMIUM. Joy Moffit and William H. Yongue, Jr., Dept. of Biology, V.P.I. & S.U., Blacksburg, VA 24061

Cultures of Euglena gracilis received sublethal temperature and acute chromium trioxide treatments. Cultures were first exposed to temperatures of 30C and 34C. There was no evidence of an effect at 30C; however, at 34C individuals rapidly died-off starting at day four when the average number of Euglena per cover slip was seven; the initial count was 63.75 per cover slip. By day 10 all Euglena were dead. Sublethal temperature was determined to be 31.5C by Yongue et.al. (1979). The effect of chromium trioxide at concentrations of 1000, 100, 10, 1, 0.1, 0.01, and 0.001 mg/l (ppm) were examined at room temperature, after being exposed to 31.5C for one hour and then returned to room temperature and after continuous expose to 31.5C. Exposure to CrO_3 concentration of 1000 mg/l caused immediate deaths. At concentration of 100 mg/l deaths occurred as early as, after one hour with complete die-off after 24 hours. At concentrations of 10 mg/l there were deaths at 1 hour, with no increased die-off after 3 hours except for the 31.5C continuous treatment. Deaths occurred after 24 hours for 10 mg/l CrO_3 treatments at room temperature.

In a previous study (Yongue et.al. 1979 J.Protozool 26:1) similar experiments were concluded after three hours. The results in this study show that chromium effect may not be apparent in that short a period. This research is being continued.

LONGEVITY IN LAND SNAILS AND THE COST OF REPRODUCTION.
James Murray. Dept. of Biology, Univ. of Va., Charlottes-
ville, Va. 22901
    Among terrestrial invertebrates, land snails are un-
usually long lived. The greatest recorded age is for an
individual of Partula taeniata, collected on Moorea in
French Polynesia on 14 August 1962, that lived until 15
March 1979, a life span of at least 16 years and 7 months.
A cohort of 31 Partula taeniata, maintained in isolation in
the laboratory, displayed a Type I survivorship curve,
indicating high survival until senescence. Median age at
death in this group was 127 months. The cost of reproduc-
tion in terms of increased probability of death can be
estimated from the survivorship of animals employed in
genetic crosses. The reduction in median age at death
amounts to at least a year. (Aided by NSF grants GB4188
and GB26382)

RECONSTITUTION OF JELLYFISH POLYPS FROM AGGREGATES OF DIS-
SOCIATED CELLS. Gayle K. Riley* and R. F. Black, Col.
William & Mary, Williamsburg, Va. 23185.
    Suspensions of single cells were prepared from polyps
and podocysts by treatment with trypsin. Cells were washed
and shaken on a rotator overnight. Polyp cells and a sub-
population of podocyst cells reaggregated to form smooth
clumps, which subsequently gave rise to polyps. A signifi-
cant subpopulation of large podocyst cells failed to reag-
gregate.
    Reaggregation was inhibited by the following d-sugars
and derivatives at the approximate molar concentrations
given: N-acetylglucosamine 10^{-3}, fucose and galactose 10^{-2},
glucosamine, mannosamine and galactosamine 10^{-1}. Glucose
and mannose did not inhibit.
    The following plant lectins agglutinated cells at the
following minimum concentrations (mg/ml): Tetragonolobus
purpureas less than 0.1, Tritcum vulgaris 0.1, Concanavalin
A 0.5. Phytohemagglutinin (Phaseolus vulgaris) was inef-
fective. Lectins clumped even the large podocyst cells
which failed to spontaneously aggregate. No difference be-
tween polyp and podocyst cells was observed in tests with
sugars or lectins.

CONTAMINATION OF FOOD CHAINS WITH PARTICULAR REFERENCE TO
VERTEBRATES. Patrick F. Scanlon. Dept. Fisheries and
Wildlife Sciences, Va. Polytechnic Inst. and State Univ.,
Blacksburg, Va. 24061
    Research on environmental contamination in the Dept. of
Fisheries and Wildlife Sciences at VPI&SU has involved work
with heavy metals and with chlorinated hydrocarbons.
Emphasis has been placed on the movement of contaminants in
food chains, and on the effects of the contaminants on
health and reproduction of vertebrate species. Research to
date has centered on the heavy metals, lead, cadmium,
nickel, and zinc as they relate to highways; on lead as a
contaminant of orchards and of management areas for upland
game birds; and several heavy metals as contaminants of
waterfowl food sources. Work with chlorinated hydrocarbons
has involved work with a PCB, Mirex, and with Kepone.
Emphasis has been placed on the effects of heavy metals and
chlorinated hydrocarbons on undernourished as well as *ad
libitum* fed animals. Funding for some of the research has
been provided by DOT and NIH.

TRYPANOSOMA MUSCULI DEVELOPMENT IN CASTRATED AND UNCASTRATED
ALBINO (SW) AND BEIGE (BG) MICE. D.K. Sen, G. D. Inman*,
and D. Lambert*. Dept. of Life Sciences, Va. State Univ.,
Petersburg, Virginia 23803
    Castrated albino (SW) and castrated beige (BG) mice in-
oculated with 5 X 10^4 Trypanosoma musculi developed a higher
parasitemia as compared to the uncastrated but infected mice
in two separate experiments. Effects of different strains
of mice on the development of trypanosomes were also examined.
    In Experiment I, an average of 36 X 10^6 cells/ml of blood
was observed at the parasitemic peak in the castrated SW mice
compared to 22.8 X 10^6 cells/ml of blood in the uncastrated
control SW counterparts. In Experiment II, an average of
66.2 X 10^6 cells/ml of blood was observed at the parasitemic
peak in the experimental castrated beige (BG) mice compared
to 46.5 X 10^6 cells/ml in the uncastrated (BG) controls.
    Of these two strains tested, BG male mice proved to be
the superior host for T. musculi. An average of 66.2 X 10^6
cells/ml of blood was observed at the parasitemic peak in
the BG mice compared to 22.8 X 10^6 cells/ml in SW male mice.
(Supported by NIH grant SO6-RR-08090-07)

EFFECTS OF CHITIN INJECTIONS AND ANTI-CHITIN IMMUNITY ON
TICK INFESTATIONS OF RATS. Janet Skinner* and S. B.
Ackerman. Department of Biological Sciences. Old
Dominion Univ. Norfolk, VA 23508.
    In 1971 a United States Patent (No. 3,590,126) was
granted to William R. Porter for an anti-tick vaccine con-
sisting of suspensions of chitin (polymeric N-acetyl gluco-
samine). Mr. Porter claimed that antibodies generated in
dogs following one chitin injection would provide long-term
in vivo protection against ticks and in vitro kill fleas
and "render ticks comatose". The present study reports
upon attempts to reinvestigate this phenomenon using con-
trolled experimental infestations of rats with the American
Dog Tick, Dermacentor variabilis. Using several assays we
have not been able to demonstrate that rats respond immuno-
logically to crude (ground crab shell) or pure (acid washed)
chitin. Although special stains have demonstrated that
proteins are associated with the chitin particles, espe-
cially the crude chitin, we have not been able to extract
the protein using various detergents. Rat hosts were
injected with saline suspensions of ground chitin either
simultaneously with or several times prior to tick infesta-
tion. No differences have been noted between chitin-
injected or control animals for attachment, feeding dynamics,
or engorgement weights of replete female ticks. Although
our investigations are continuing, it appears that for rat
hosts chitin is not effective as an anti-tick vaccine.

A PROCEDURE FOR INCREASING RAT HYPOPHYSECTOMY SUCCESS RATES
IN ENDOCRINE EXPERIMENTS. R. J. Swanson, Dept. of
Biological Sciences, Old Dominion Univ., Norfolk, Va.
23508
    Success rates for complete hypophysectomy of rats is
increased from sixty to ninety percent using a glass funnel
developed for this procedure. Using a gas flame, a
3/8-inch section of Pasteur pipette is taken at the
restriction point and joined to a solid glass rod. A
parapharyngeal approach is taken to reach the midsagittal
juncture of the occipital and sphenoid bones (OSJ). To
maintain tracheal patency, the experimenters inserted a
length of plastic Clay-Adams intramedic tubing of
appropriate size for the age rat being used. In prepara-
tion for drilling the burr hole, the capitus muscles were
scraped from the basilar occipital bone and the pharyngeal
constrictors, originating on the posterior rim of the
sphenoid, retracted from the midline. The funnel, doubling
as a retractor, allows the investigator to see the mid-
sagittal OSJ and avoid wrapping the adjacent tissue around
the spinning burr.

AN ULTRASTRUCTURAL STUDY OF THE MANTLE IN THE OSMORECULATING CLAM *RANGIA CUNEATA*. R. Turnage* and C.P. Mangum. Dept. of Biol., Col. of William and Mary, Williamsburg, Va. 23185

The mactrid clam, *Rangia cuneata*, is able to tolerate a wide range of salinities and has been reported in waters of 0 to 25°/oo. At salinities below 4°/oo it is capable of maintaining its hemolymph hyperosmotic to the surrounding medium and it is thought that the site of osmoregulation is the mantle. This study was initiated to determine if the ultrastructure of the mantle resembles that of other transporting epithelia. Preliminary evidence has shown that both the outer and inner epithelial layers of the mantle have many of the characteristics of transporting tissue.

THE RESPIRATORY ROLE OF CHLOROCRUORIN. C. M. Vogel* (Intro. by C. P. Mangum). Dept. of Biology, College of William and Mary, Williamsburg, Va. 23185

The purpose of the present study was to investigate the respiratory role of the oxygen carrier chlorocruorin in the blood of Eudistylia vancouveri, a subtidal annelid inhabiting waters high in oxygen. The effects of carbon monoxide blockage on oxygen uptake was maximal at high PO_2s, and was reduced at low PO_2s. Tube ventilation does not appear to be affected by carbon monoxide. These results suggest that the optimal function of chlorocruorin from E. vancouveri occurs at high PO_2s, which is consistent with the exceptionally low oxygen affinity of the molecule.

MIGRATORY BEHAVIOR OF AEDES CANTATOR (DIPTERA: CULICIDAE) IN SOUTHERN MARYLAND. S.C. Weaver*and N.J. Fashing. Col. of William and Mary, Williamsburg, Va. 23185

Three Aedes cantator (Coquillett) broods were monitored in the vicinity of a salt marsh during 1978. Landing rates and parous rates were determined semi-weekly at four sites extending 2 km inland from the marsh-upland ecotone. In addition, the marsh was frequently inspected for Ae. cantator larvae, and a light trap was operated at the marsh edge to detect brood emergence. Data indicate that many females migrate 2 km or more inland after emergence and return to the marsh for oviposition. Parous mosquitos returned inland for additional blood feeding and no inhibition of migratory tendency was detected.

Landing rates indicate that nuisance persisted several weeks past brood emergence at all sites. Parous mosquitos were present at all sampling locations during most of the study period, and no significant difference in vector potential was found at any of the study sites. Evidence suggests that Ae. cantator migration may be density dependent and serves to reduce both intra- and interspecific competition.

SOME ULTRASTRUCTURAL OBSERVATIONS OF DESMOGNATHUS (CAUDATA, PLETHODONTIDAE) SPERMATOZOA. J. W. Edward Wortham, Jr. and Jerry S. Vande Berg*, Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508.

Spermatozoa from the vasa deferentia and testes of Desmognathus ochrophaeus were studied with the transmission electron microscope. The emphasis of this study was placed on the cytoplasmic constituents, in particular the cytoplasmic droplet.

The cytoplasmic droplets were limited by a single membrane and located on the side of the axial rod opposite the undulating membrane and flagellum. The droplets were ultrastructurally complex and contained smooth endoplasmic reticulum, ribosomes, myelin-like structures, membrane bound P-bodies and mitochondria. The membrane bound P-bodies contained groups of parallel filaments each about 150 A° in diameter. These P-bodies were present in testicular material but they were more abundant in the cytoplasmic droplets of spermatozoa taken from the vas deferens. Mitochondria in the droplets could be found randomly scattered in the cytoplasmic matrix or grouped into small clusters. Several mitochondria were found attached together by intermitochondrial junctions.

While the spermatozoan cytoplasmic droplet is a highly complex structure, its functional significance remains unknown.

THE INFECTIOUS AGENT OF CYTOTODDIA (=TODDIA BUFONIS). William H. Yongue, Jr., and Katherine A. Booker. Dept. of Biology, V.P.I. & S.U., Blacksburg, VA 24061

The species name Toddia bufonis was erected (Francea, 1911. Camara-Pestana, 3:229-238) for a basophilic body with an associated crystal-like inclusion in erythrocytes of a toad. Since then several species of Toddia have been described from other species of poikilotherms. Marquardt and Yeager (1967. J. Protozool. 14(4)) proposed that the basophilic body must be a DNA-type virus. Earlier, (Yongue, 1965. J. Elisha Mitchell Sci. Soc.) it had been suggested that the basophilic body was not a protozoan parasite nor was it the infectious agent. Cytotoddia was used as a designation for the general condition seen in blood cells of Natrix (=Nerodia) sipedon sipedon.

In 1978, electron microscopy (TEM) revealed widely distributed apparently polyhedral bodies measuring ca. 0.22x0.16μm. Some appeared to be undergoing binary fission. They were not clumped into basophilic masses. To test that the bodies were the infectious agent of cytotoddia, blood cells from a naturally infected water snake (Sip #7) were lysed in distilled water and injected (i.p.) through a 0.45 μm filter into 3 young water snakes with proven negative histories. All showed all characteristics of cytotoddia 14 days post-inoculation.

DYNAMICS OF PROTOZOAN ASSEMBLAGES IN A NEW POND. William H. Yongue, Jr., John Cairns, Jr., and Michael Van Brunt. Dept. of Biology, V.P.I. & S.U., Blacksburg, VA 24061

Polyurethane foam units (PFUs) were used to study the colonization rate of protozoans and the presence of other microscopic organisms in a recently dug pond that is in the early stages of filling. The pond, a unit of the V.P.I. & S.U. Horton Center on Salt Pond Mountain, Ciles County, Virginia was specifically dug to be used in aquatic microbial research. This work represents a baseline study. PFUs were anchored in the pond 28 May 1978 and the final units of this set were harvested 6 September 1978; ninety-nine days later. Total hardness, alkalinity and dissolved oxygen were relatively stable but pH increased from 7.5 (Day-o) to 9.3 (Day-99) and CO_2 from 2 to 10 ppm.

The colonization of protozoans increased from 2 species on Day-2 to a high of 26 on Day-22, after which the numbers dropped and oscillated about a mean of 15.2 (N=10; s=3.33). The most common genera were: Cryptomonas, Amoeba, Cinetochilum, Bursella, Stentor and Vorticella.

Other miciobiota in PFUs included Rotifera (7 genera), nauplii, Algae (5 genera) Stenostomum, Aelosoma, Castroticha and insect larvae. (A contribution of the Dr. M. C. Horton Aquatic Microbial Laboratory and the Center for Environmental Studies)

Botany

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SOIL MOISTURE AND THE DISTRIBUTION OF QUERCUS RUBRA AND
QUERCUS PRINUS. Douglas E. Blackman* and Stewart A. Ware,
Dept. of Biology, The College of William and Mary, Williams-
burg, Va. 23185
    Because Keever found in Pennsylvania that Quercus
prinus occurred in moister sites than Quercus rubra, in
sharp contrast to conventional wisdom, a study was under-
taken of the relationship between the distribution of
these two species and soil moisture in the Blue Ridge of
Virginia. Two study areas were used; seven stands near
Afton Mountain in the north and eight stands near the
Peaks of Otter in the center of the Blue Ridge. Stands
were selected at different altitudes and with varying
degrees and directions of slope. Soil moisture measure-
ments were taken at each stand on a biweekly basis through
the growing season using buried gypsum blocks and a Bou-
couyos moisture meter. In the Peaks of Otter area, Quercus
rubra stands had much higher average soil moisture than
Quercus prinus stands. Quercus prinus stands also had long
periods of consecutive weeks under twenty-five percent soil
moisture, unlike the Quercus rubra stands. However, the
Afton Mountain stands did not have consistent correlations
with either the overall soil moisture or the number of con-
secutive weeks under twenty-five percent soil moisture. The
Peaks of Otter data does support the conventional opinion;
however, the Afton Mountain data supports Keever's conclu-
sion that there is no consistent correlation between the
species and soil moisture.

MELANTHIUM HYBRIDUM WALT. – A MISAPPLIED NAME. Norlyn L.
Bodkin. Dept. of Biology, James Madison Univ., Harrison-
burg, VA 22807
    Melanthium L. (Liliaceae) is a genus of perhaps eight
species with the four species of North America distributed
from central Iowa eastward to southern New York, south to
northern Florida and eastern Texas. The combination, *M.
hybridum* Walt., which has been traditionally used for one
of the mid-Appalachian species is a misapplied name not in
accordance with the rules of nomenclature. *Melanthium
hybridum* was described by Thomas Walter in Flora caro-
liniana in 1788. There are insoluable problems in typify-
ing this ambiguous name, ones relating to both the unasso-
ciable original description and the lack of any authentic
type material. Walter's description does not fit the
species which has been traditionally called *M. hybridum*.
References have been made to this erroneous application of
the name but the nomenclatural dispositions necessitated by
this recognition have not been forthcoming.
    The next priorable name for this species is *Melanthium
latifolium* Desr. Dessrousseaux published this name in 1797
in Lamarck's Encyclopodie methodique. Botanique. The des-
cription is very thorough and includes the characteristics
commonly attributed to *M. hybridum*. Use of *M. latifolium*
Desr. for this species conforms with the rules in the Inter-
national Code of Botanical Nomenclature and is, therefore,
the correct name for this species.

NEW PLANT DISTRIBUTION RECORDS IN NORTHERN VIRGINIA.
Ted Bradley. Dept. of Biology, George Mason University,
Fairfax, Va. 22030.

    Recent collections of flowering plants from northern
Virginia have revealed several unusual records. Species
spreading from cultivation and here reported as apparently
new for Virginia are Ornithogalum nutans (Liliceae),
Betula pendula (Betulaceae), Ulmus parviflora and U. pumila
(Ulmaceae). Erigenia bulbosa (Apiaceae) and Floerkia
proserpinacoides (Limnanthaceae) are reported from near the
Shenandoah River in Clarke Co. Northern range extensions in
Virginia are Matelea suberosa (Asclepiadaceae) from West-
moreland Co., Ludwigia leptocarpa (Onagraceae) from King
George Co., and Symplocos tinctoria (Symplocaceae) from
Caroline Co.

Enzymatic Changes Associated with Juvenile and Adult Forms
of English Ivy (Hedera helix L.)
B. Budowle and A. Esen, Dept. of Biology, Virginia
Polytechnic Institute and State University, Blacksburg,
Virginia 24061

    The two distinct morphological and physiological forms,
juvenile and adult, of English Ivy, Hedera helix, are more
pronounced than in any other woody plant. These two forms
provide an ideal model for studying biochemical differences
associated with phase change. The enzymes alphaamylase,
catalase, esterase, malate dehydrogenase, and superoxide
dismutase have higher activities in juvenile than adult
leaves. Conversely, acid phosphatase, glutamate dehydro-
genase, peroxidase, and protease activities are higher in
adult compared to juvenile leaves. No activities for
glutamate-oxaloacetate transaminase, leucine aminopeptidase,
monoamine oxidase, and ribonuclease could be detected in
either juvenile or adult leaves. In addition, zymograms
of the juvenile and adult leaves displayed qualitative
differences.

LITTER DECOMPOSITION RATES IN THE DISMAL SWAMP. F. P. Day, Jr. Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508.

Leaf litter decomposition rates are being measured by the nylon mesh bag technique in four plant communities in the Dismal Swamp. The communities differ primarily in species composition and frequency and duration of flooding. A preliminary examination of the data suggests that decomposition rates are highest for mixed species litter on the more extensively flooded sites, which also have higher soil and water pH's. Tupelo gum (Nyssa aquatica L.) leaves decomposed faster than the other dominant species' leaves, oaks (Quercus spp.), cypress (Taxodium distichum (L.) Richard), and Atlantic white cedar (Chamaecyparis thyoides (L.) BSP.). Decomposition in periodically flooded swamps appears to be affected by the duration and frequency of inundation.

ESTIMATION OF PROTEIN QUALITY AND QUANTITY IN CEREALS. A. Esen. Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061

Alcohol-soluble proteins, prolamines, make up 40-60% of the protein in cereal grains. These proteins are deficient in several essential amino acids, lysine in particular, and render cereals a low quality protein source. A screening method was developed to identify high quality and/or quantity protein cereal mutants. Proteins from whole kernel meals were recovered in two solubility fractions. Fraction 1 includes prolamines, extracted with 60% t-butanol, and Fraction 2, nonprolamines, includes albumins, globulins, glutelins and others, extracted with a high pH buffer containing an ionic detergent (SDS) and a reducing agent (2-mercaptoethanol). Protein content of the two fractions, assayed by a simple dye-binding method, gives an estimate of protein quantity in the sample. The ratio of prolamine to nonprolamine yields an estimate of protein quality. The method offers promise as a simple and rapid mass-screening tool for identifying cereal mutants with high quality and/or quantity protein.

FLOWER ABUNDANCE, ACORN MORTALITY AND MAST IN WHITE OAK (QUERCUS ALBA L.). P. P. Feret and R. E. Kreh. Dept of Forestry, Virginia Polytechnic Inst. and State University, Blacksburg, VA 24061.

Several white oak trees aged 37-69 years and varying in height from 18-21 meters were observed for three consecutive growing seasons. Measured were flower and peduncle abundance, flower and fruit periodic mortality during the growing season, and mast production/m^2 of crown area projected to ground level. Trees that flowered in one year did not always flower. Both "good" and "poor" mast crops were recorded with trees producing from 0 to 6.7 flowers/shoot and from 0 to almost 300 acorns/m^2. Mortality of flowers from day of pollinations to seed maturation averaged about 70%. A relationship was observed between numbers of flowers at pollination and mast produced by 180 days from pollination.

EVALUATION OF HUMIDITY EFFECTS ON LEVELS OF OXIDATIVE ENZYMES IN COTTON LEAF TISSUE. J. G. Foster and J. L. Hess, Dept. of Biochemistry & Nutrition, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061

Effects of an elevation in humidity from 70% to 95% on levels of soluble protein and activities of oxidative enzymes were evaluated in extracts from Gossypium herbaceum L. C.B. 1697 leaf tissue exposed to otherwise typical growth conditions. Light was provided at 200-300 $\mu E/m^2$ sec during a 16 hr day, and temperature was maintained at 30°. Hoagland's nutrient (20%) was provided on alternate days. Leaves, 2-4 weeks of age, were harvested at 24 hr intervals for 5 days following the elevation in humidity. After homogenization, extracts were centrifuged; supernatants were chromatographed on Sephadex G-50; and the soluble protein fraction was assayed for enzyme activities. Decreasing yields of soluble protein/g fresh tissue during the experimental period (-23%) were consistent with symptoms of water accumulation in the leaves and a 30% decrease in the dry weight/fresh weight ratio. Concomitant decreases in glycolate oxidase (-37%) and catalase (-28%) activities on the basis of fresh tissue weight, but not as a function of soluble protein, reflect the increasing contribution of water to fresh tissue weight. An increase in the specific activity of peroxidase (+186%) during the same period suggests a real change in the levels of that enzyme in response to the high humidity and indicates a need to regulate humidity to which plants are exposed during enzyme studies. (Support: CSRS grant # 316-15-93)

A COMPARATIVE STUDY OF LITTER FALL RATES IN THE GREAT DISMAL SWAMP, VA. M. Gomez* and F. P. Day, Jr. Dept. of Biology, Old Dominion Univ., Norfolk, Va. 23508.

Litter fall rates for four different plant communities in the Great Dismal Swamp, Va. were measured. The four sites differ in dominant vegetation and degree of flooding. The Taxodium distichum (L.) Richard community had the highest mean annual total litter fall of 852 gm^{-2}, followed by the Chamaecyparis thyoides (L.) BSP. community with 847 gm^{-2}, the Acer-Nyssa community with 831 gm^{-2} and the mixed hardwood (Quercus, Acer, Nyssa, Liquidambar) community with 759 gm^{-2}. Leaf fall as a percentage of total litter fall for each site was 80%, 72%, 86% and 75%, respectively. Annual rates of deposition of wood, fruits and flowers were also estimated. Seasonal inputs of litter were evaluated.

THE POLLINATION ECOLOGY OF FOUR NORTH AMERICAN ORCHIDS. J. Hecker*, N.J.Fashing and G.W. Hall, Dept. of Biology, College of William and Mary, Williamsburg, Va. 23185.

The pollination ecology of four North American orchids (Cypripedium acaule, Goodyera pubescens, Ponthieva racemosa and Tipularia discolor) was studied in Tidewater, Virginia. During the blooming period of each species, data was collected on flower morphology, phenology and breeding system. The presence of insect visitors, their behavior and their effectiveness as pollinators were also studied.

No insects were observed visiting C. acaule, and only six percent of the flowers were pollinated. Although only three halictine and one anthophorine bee were observed visiting G. pubescens, 40% of the flowers were pollinated. P. racemosa was visited by three hymenopteran families (8 species) and four dipteran families (13 species). Of those capable of effecting pollination, 36% were hymenopterans, primarily Halictidae, and 64% were dipterans, primarily Calliphoridae and Tachinidae. Seventy-eight percent of the P. racemosa flowers were pollinated. T. discolor was visited by noctuid moths, and 42% of the flowers were pollinated. All four orchids were observed to set seed when artificially self- and cross-pollinated; none appeared to be autogamous. Pollinators visit P. racemosa and T. discolor to obtain nectar and are probably attracted by odor, although flower color may also play a role.

THE HETEROGENEITY OF SOYBEAN SEED PROTEINS.
B. T. Hu and A. Esen. Dept. of Biology, Virginia
Polytechnic Inst. & State Univ., Blacksburg,
Virginia 24060
    Protein components are obtained by exhaustive
sequential extraction of defatted soybean meal
(Glycine max var Dorman), then subjected to the
sodium dodecyl sulfate gradient (10-15%) poly-
acrylamide gel electrophoresis (SDS-PAGE), iso-
electric focusing (IEF) and two-dimensional poly-
acrylamide gel electrophoresis (2-D PAGE).
    365 polypeptides from six different extractions
of soybean seeds were separated by 10-15% gradient
SDS-PAGE; and 268 polypeptides from four extracts
                 were obtained by IEF. The 2-D
protein profiles from water and salt extracts
contained over 1000 spots.

YELLOW-POPLAR (LIRIODENDRON TULIPFERA L.) SEEDFALL AND
ACCUMULATION IN AN UNDERSTOCKED BOTTOMLAND SITE ON THE
VIRGINIA PIEDMONT. R. E. Kreh* and P. P. Feret. Dept. of
Forestry, Reynolds Homestead Research Center, VPI & SU.
Critz, VA 24082.
    Samples of seedfall and accumulated seed were taken
from a bottomland site in Piedmont Virginia. The average
number of yellow-poplar stems greater than 5cm in dia-
meter at 1.4m above the ground was 140/ha and the total
for this species was 600/ha. The most abundant tree
species (but with a very non-random distribution) on the
site was Virginia pine (Pinus virginiana Mill.) with
624/ha of which 176/ha had stems greater than 5cm in dia-
meter at 1.4m above the ground. Honeysuckle (Lonicera
japonica) was the dominant understory vegetation with an
average cover of 48%. Annual seedfall, ranged from 2.6
million/ha to 10.5 million/ha during the 1978 season.
X-ray analysis indicated that an average of 3.8% of the
1978 seedfall contained at least 1 sound seed per samara.
Accumulated yellow-poplar ranged from $102/m^2$ to $892/m^2$.
The large amounts of seedfall and accumulated seed indi-
cate that seeding is not the limiting factor in yellow-
poplar stand estalbishment on the site studied. Lonicera
cover and lack of mechanical disburbance were thought to
be the primary factors effecting seedling establishment.

FIRST YEAR SURVIVAL AND GROWTH OF LEUCAENA LEUCOCEPHALA
IN THE REPUBLIC OF HAITI. D. O. Lantagne*, D. Wm. Smith.
Dept. of Forestry and Forest Products, Va. Polytechnic
Inst., Blacksburg, VA 24061.
    In the fall of 1977 seedlings of Leucaena leucocephala
and other introduced and native species were planted in
four trial plantations within northwestern Haiti. Planta-
tion sites ranged in elevation from 40 meters above sea
level to 620 m above sea level on soil types varying in
depth, characteristics and slope.
    Five replications of at least twelve species occurred
in every trial plantation. After ten months Leucaena
leucocephala var K-8 showed considerable growth gains
across all elevations and soil types where it occurred.
Average height growth for the ten month period was 1.85 m
at 620 m asl to 3.50 m at 40 m asl.
    Leucaena showed great promise for biomass production,
use in the charcoal industry, the local wood industry and
as an erosion control species.

IN VITRO AND IN VIVO INHIBITION OF POLYPHENOL-
OXIDASE ACTIVITY BY BENZOIC ACID DERIVATIVES IN
THE TETRASPORE ASCOMYCETE PODOSPORA ANSERINA
NIESSL. Cynthia A. Manshack*, sponsored by James
E. Perham. Randolph-Macon Woman's Col., Lynchburg,
VA 24503
    p-Aminobenzoic acid has been shown to inhibit
perithecial formation in Podospora anserina
Niessl, while non-competitively inhibiting tyros-
inase activity and stimulating laccase activity.
PABA also inhibits the polymerization of melanin.
    Several other benzoic acid derivatives were
tested for their effects upon the activities of
these polyphenoloxidases and upon melanin poly-
merization and perithecial formation. Enzyme
activities were determined by spectrophotometri-
cally monitoring dopachrome formation.
    Benzoic acid and its p-substituted derivatives
were found to inhibit tyrosinase activity, while
its m- and o-substituted derivatives showed no
effect. Laccase activity was stimulated by amino-
substituted derivatives, but was unaffected by
others. Melanin polymerization was inhibited by
the amino-substituted derivatives. In in vivo
tests, only benzoic acid and its p-substituted
derivatives inhibited perithecial formation.

SEASONAL PHYTOPLANKTON COMPOSITION IN THE LOWER CHESAPEAKE
BAY AND OLD PLANTATION CREEK, CAPE CHARLES, VIRGINIA.
H. G. Marshall, Dept. Biological Sciences, Old Dominion
Univ., Norfolk, Va. 23508.
    During a 14 month phytoplankton study in the lower
Chesapeake Bay, there was a bi-modal pattern of popula-
tion peaks with fall-spring maxima. The phytoplankton was
dominated by Skeletonema costatum and other major diatoms
similar to dominants found on the continental shelf. The
composition in an adjacent inlet, Old Plantation Creek,
was similar throughout most of the period, but differed
mainly from Bay populations during the summer months when
larger concentrations and diversity of phytoflagellates
and small sized diatoms occurred. The composition of the
phytoplankton is considered estuarine with a makeup
characteristic to a turbulent and estuarine setting. A
total of 215 phytoplankters were recorded with dominant
species common to the upper and lower Chesapeake Bay
noted. These were Asterionella japonica, and Skeletonema
costatum in the winter; A. japonica, S. costatum, Cera-
taulina bergonii and Rhizosolenia fragilissima in spring;
Coscinodiscus marginatus, Rhizosolenia calcar avis, and
Ceratium furca in summer; S. costatum and Chaeteceros
socialis in the fall.

ABOVE-GROUND PHYTOMASS AND NUTRIENTS IN THE UNDERSTORY
VEGETATION IN AN APPALACHIAN OAK FOREST IN SOUTHWESTERN
VIRGINIA. Wayne L. Martin*, Terry L. Sharik, David Wm.
Smith, Dept. of Forestry, Va. Polytechnic Inst., Blacks-
burg, VA 24061
    Destructive sampling was undertaken to estimate the
contribution of the herb stratum and shrub stratum to
above-ground phytomass and nutrients (N, P, K, Mg and Ca)
in four different vegetation types in an Appalachian Oak
Forest in southwestern Virginia. The study area is lo-
cated at midslope on the southeast aspect of Potts Moun-
tain in four non-contiguous compartments which are to be
clearcut and whole-tree harvested in the near future. A
partial random sampling scheme was utilized to select 20x
20 m study areas, within which 48 1x1 m and 16 5x5 m herb
and shrub stratum plots were nested respectively. Sta-
tistical tests indicated that significant differences in
above-ground phytomass and nutrients exist between vege-
tation types in both strata. The trend is towards greater
amounts of understory vegetation on progressively drier
sites. Total amounts (kg/ha) of nutrient elements show a
similiar trend. In contrast, nutrient element concentra-
tions show a reverse trend, with higher concentrations of
nutrients found on the more mesic sites. Ordination tech-
niques were utilized to investigate differences in nutri-
ent concentrations among species. Species groupings de-
rived from the ordinations substantiated the sorting of
vegetation types along a moisture gradient.

INVESTIGATION OF THE PISTILLATE ONTOGENY OF WHITE OAK (QUERCUS ALBA L.) BY SCANNING ELECTRON MICROSCOPY. S. A. Merkle, P. P. Feret*, J. G. Croxdale, and T. L. Sharik. Dept. of Forestry, Dept. of Forestry, Dept. of Biology, Dept. of Forestry, Va. Polytechnic Inst., Blacksburg, Va., 24061.

The ontogeny of pistillate structures of white oak (Quercus alba L.) was traced using scanning electron microscopy. It was found that in the Virginia trees sampled, pistillate inflorescences are initiated in late summer in the axils of developing leaf primordia in the bud. These inflorescence primordia show little differentiation before dormancy in October and are difficult to distinguish from lateral bud primordia during their early development. The most mature inflorescence primordia may produce one or two bracts near the inflorescence base by October. By late March, the inflorescence resumes development, adding bracts and enlarging rapidly. In early April, individual pistillate flowers are produced in the bract axils. The pistillate flowers complete virtually all of their structural development, producing a perianth and three carpels, during the three weeks prior to anthesis.

INVESTIGATION OF THE STAMINATE ONTOGENY OF WHITE OAK (QUERCUS ALBA L.) BY SCANNING ELECTRON MICROSCOPY. S. A. Merkle, P. P. Feret*, J. G. Croxdale, and T. L. Sharik. Dept. of Forestry, Dept. of Forestry, Dept. of Biology, Dept. of Forestry, Va. Polytechnic Inst., Blacksburg, Va., 24061.

The ontogeny of staminate structures of white oak (Quercus alba L.) was traced using scanning electron microscopy. It was found that in the Virginia trees sampled, staminate inflorescences (catkins) are initiated in developing buds in late May. Individual staminate flowers arise on the inflorescence axis in late June or early July as rounded meristematic areas, and mature in an acropetal direction on the axis. By early August, the most mature staminate flowers on the catkin show development of a perianth ring and anthers. Anthers show lobing by late September and all flowers on the catkin are structurally mature before the onset of dormancy in October. The staminate structures resume development in mid-March and the catkins emerge from the buds in early April. The pollen grains are three-lobed and show no conspicuous surface appendages.

PROBLEMS AND POTENTIALS OF DENDROCLIMATOLOGY IN VIRGINIA. R. L. Phipps. Tree-Ring Lab., M.S. 461, U. S. Geological Survey, Reston, Va. 22092.

Recent work in Virginia indicates that growth rings of trees in the humid, eastern deciduous forests can be accurately dated, and, in some cases, ring widths can be correlated with climatic and hydrologic factors. Significant correlations have been found with records of July lake level (Lake Drummond), June-July precipitation (Dismal Swamp), and indices of July drought severity (Northern Virginia). Late spring temperatures and mid-summer streamflow also appear to be significantly correlated with tree growth.

Significant correlation of growth with a single environmental factor, allows reconstruction of that factor from tree-ring data. At the present time relatively few tree-ring records have been obtained which are both climatically sensitive and long enough to permit reconstruction. Such records are difficult to obtain because not enough is known of the species-habitat combinations which yield the most sensitive collections, and because of the relatively few stands of old trees. Sites which result in severe internal water stress in the trees appear most promising. Sites where lack of water limits growth have been shown to contain trees with climatically sensitive ring records. However, in Virginia, sites which to date have produced the most environmentally sensitive ring records are those where overabundance of water has limited growth.

RECONSTRUCTION OF DROUGHT IN VIRGINIA: A DENDROCLIMATIC INVESTIGATION. L. J. Puckett*. Tree-Ring Lab., M.S. 461, U. S. Geological Survey, Reston, Va. 22092

A 230-year record of the Palmer Drought Severity Index (PDSI) was reconstructed for northern Virginia from variations in widths of tree rings. Incremental cores were extracted from eastern hemlock (Tsuga canadensis (L.) Carr.) at three locations in northern Virginia. Measurements of annual growth increments were made and converted to indices of growth.

A response function was derived for hemlock to determine the growth-climate relationship. Growth was positively correlated with precipitation and negatively correlated with temperature during the May-July growing season.

Standardized indices of growth were calibrated with the July PDSI. Growth accounted for 24-30% of the PDSI variance. Further regressions using principle components of combined tree growth indices resulted in a small but significant improvement. Greatest improvement was made by extracting principle components of individual tree growth indices thereby accounting for 64% of July PDSI variance in the regression.

Comparison of the results with a 279-year reconstruction from New York showed considerable agreement between low-frequency climatic trends. These results are very encouraging and suggest that network collections throughout the East may yield significant information about patterns of widespread drought.

STUDIES IN THE VIRGINIA RANUNCULACEAE. Gwynn W. Ramsey, Dept. of Biology, Lynchburg College, Lynchburg, Virginia 24501

Taxonomic and distributional studies have been in progress on the Buttercup Family in Virginia for several years. Field and Herbarium studies reveal new taxa within this family for the state and some very interesting distribution patterns are noted. Several species are endemic to Virginia and others may be rare, threatened, or endangered. Eighteen (18) genera and sixty-eight (68) species are recorded. There are no Ranunculaceae recorded for at least one Virginia county. Some nomenclatural changes are necessary.

THE SMALL ARBORETUM—A TEACHING TOOL. Gwynn W. Ramsey, Dept. of Biology, Lynchburg College, Lynchburg, Virginia 24501

An effective arboretum does not have to be large. A small naturally wooded area may be fenced and maintained as an arboretum for the explicit purpose of furthering botanical interest and study. There are multiple possibilities for utilizing the small arboretum which can serve also as a natural meeting ground for Science, History, Art, and Culture in general. Adaptable to all levels of education and degrees of complexity, various studies in the small arboretum may serve as a means of preview, drill, review, enrichment, and/or evaluation; and they may function on an individual and/or classroom basis. Arboretum studies might also arouse interest, cultivate observation and discovery powers, and establish lifelong hobbies. Development, use, and maintenance of the three acre Lynchburg College Arboretum strengthened by a unique arrangement with a Forest Products Industry are topics included in the presentation. Suggestions for kinds of studies within the small arboretum will be made.

PSYCHROPHILIC ALGAE FROM SOUTH VICTORIALAND LAKES.
K.G. Seaburg*, B.C. Parker, and R.A. Wharton, Jr.
Dept. of Biology, Va. Polytechnic Inst. and State
Univ., Blacksburg, Va. 24061.
Investigations of 11 South Victorialand aqua-
tic ecosystems revealed 101 algal taxa, 30 of
which 136 clones were isolated into unialgal cul-
tures. Following gradual acclimation, these cul-
tures were assayed for growth at temperatures from
2-25 C. Four species were psychrophilic, i.e.,
incapable of growth at 20 C or higher and capable
of growth at temperatures below 5 C. The most im-
portant algae in terms of biomass in Antarctica,
Nostoc spp. and Phormidium spp., were not psychro-
philes; thus, their growth may be limited to
microhabitats in which temperatures rise above the
ambient air or water temperatures. The role of
psychrophiles may be most important within the
plankton community. Soil and littoral benthic
algae from these ecosystems were mostly small
cosmopolitan taxa which are known to be easily
dispersed by wind.

THE STATUS OF THE ENDANGERED VIRGINIA ROUND-LEAF BIRCH,
BETULA UBER (ASHE) FERNALD. Terry L. Sharik, Robert H.
Ford*, Peter P. Feret., Dept. of Forestry, Va. Polytech-
nic Inst., Blacksburg, VA. 24061.
Since its rediscovery in August 1975 the single known
natural population of B. uber has declined somewhat,
mainly due to vandalism. It now consists of 20 individuals
in the wild, 11 of which are reproductively mature. The
Betula uber Protection, Management and Research Co-ordina-
ting Committee was created in 1977 to aid in protection
and recovery of the species. Protective retaining fences,
public information programs, and propagation methods have
been established under the Committee's guidance. Current
research is aimed at elucidating the ecology, genetics and
evolutionary affinities of B. uber. A long-term Recovery
Plan will be developed within the upcoming year in coopera-
tion with the Endangered Species Office of the U. S. Fish
and Wildlife Service. The ultimate objective of the plan
is to increase the number of individuals in the wild to a
point where B. uber can be discharged of its present
status as an endangered species.

CONTROL OF FUSARIUM WILT OF TOMATO WITH CYCOCEL® AND LIGNA-
SAN BLP®. C. A. Spoor, R. J. Stipes, D. M. Orcutt and R. W.
Tillman. Dept. of Plant Pathology and Physiology, Virginia
Polytechnic Institute and State University, Blacksburg, Va.
24061.
Greenhouse-grown tomato plants artificially inoculated
with Fusarium oxysporum f. sp. lycopersici were treated by
soil drench with 100 µg/ml Cycocel® (2-chloroethyltrimethyl-
ammonium chloride) and/or 500 µg/ml Lignasan BLP® (methyl
2-benzimidazolecarbamate phosphate). The chemicals were
applied one week before, one week after, and one week before
and after inoculation in Experiment 1 and one week or one
and two weeks after inoculation in Experiments 2 and 3.
Disease control was evaluated by external symptom expression,
height, shoot dry weight, root dry weight, total (shoot and
root) dry weight, and the presence of the pathogen in the
stem. Plants receiving treatments containing Lignasan BLP®
showed good control. Plants treated with Cycocel showed
little, if any, control. Growth of the pathogen on Cycocel®
amended glucose yeast extract agar was not inhibited at con-
centrations of 50, 100, 500, 1000 or 2000 µg/ml.

COMPARATIVE DISTRIBUTION OF ARBOTECT 20-S®, CGA 64251,LIGNA-
SAN BLP® AND NUARIMOL IN Ulmus americana FOLLOWING ADMINI-
STRATION WITH A STERRETT-CREAGER MINIATURE PRESSURE INJECTOR.
P. A. Truax, R. J. Stipes and R. W. Tillman. Dept. of Plant
Pathology & Physiology, Virginia Polytechnic Institute and
State University, Blacksburg, VA 24061.
Two studies (I & II) were conducted to determine the dis-
tribution profiles in Ulmus americana of A = Arbotect 20-S®
(2-(4-thiazolyl)-benzimidazole hypophosphite), C = CGA 64251
(chemistry not divulged), F = fenarimol (α-(2-chlorophenyl)
-α-(4-chlorophenyl)-5-pyrimidine methanol), L = Lignasan BLP®
(methyl 2-benzimidazolecarbamate phosphate) and N = nuarimol
(α-(chlorophenyl)-α-(4-fluorophenyl)-5-pyrimidine methanol).
In I, A, F & L were administered at 8,000 µg/ml by gravity
flow to 12-yr-old trees in Sept., 1977. Trees were sacrifi-
ced and bioassayed 1 mo. later by overspraying biopsy disks
with Ceratocystis ulmi or Glomerella cingulata, and fungal
growth inhibition was estimated from the total area of the
disc cross-sections. Fungitoxicant distribution varied
greatly and may indicate non-uniform protection or therapy.
In II, 8-yr-old nursery elm branches were pressure-injected
during summer, 1978, with known quantities of A, C, L & N
at 5,000 µg/ml using the Sterrett-Creager mini-injector.
Branches were bioassayed 2 mo. after injection and similar
non-uniform distribution patterns were found. Results of
I & II demonstrated inadequacies associated with Dutch elm
disease control due to erratic and unpredictable fungitoxi-
cant movement.

A SYSTEMATIC SURVEY OF SELECTED GENERA OF THE TRIBE
HELIANTHEAE IN VIRGINIA. S. von Oettingen. Dept. of
Biology, College of William and Mary, Williamsburg,
Va. 23185
This study is a systematic treatment of a portion of
the Heliantheae which is considered to be the most
primitive tribe of the family Asteraceae. Nine genera
[Iva (3 sp.), Ambrosia L. (3 sp.), Xanthium (2 sp.),
Heliopsis Pers. (1 sp.), Eclipta L. (1 sp.), Tetragono-
theca L. (1 sp.), Rudbeckia (5 sp.), Echinacea Moench.
(3 sp.), Ratibida Raf. (1 sp.)] were examined. Data was
obtained from examination of over 800 specimens from
seven herbaria, from observations and extensive collec-
tions made in the field, and from the literature. Voucher
specimens have been deposited in the herbarium of the
College of William and Mary. Keys to the genera and
species, descriptions, ecological data, and county-
based distributional information are included.

COMPARATIVE STUDIES OF AQUATIC ECOSYSTEMS IN SOUTH
VICTORIALAND, ANTARCTICA. R.A. Wharton, Jr.*, B.C. Parker,
and K.G. Seaburg*. Dept. of Biology, Va. Polytechnic Inst.
and State Univ., Blacksburg, Va. 24061
During the first austral summer (1977-78) of the project
"Ecosystems Comparisons of Oasis Lakes and Soils (ECOLS)",
one river and 10 lakes were investigated in the largest
oasis or ice-free area on the Continent. While these
aquatic bodies are separated by less than 80 km and are
subjected to similar climatic regimes, they exhibit a
striking range in their physiochemical and biological
properties. Based on algal species diversity, phytoplankton
biomass, development of a food chain, and such measurements
as carbon-14 primary productivity, ATP, chlorophyll a, and
water chemistry, Lakes Fryxell and Vanda represent the
highest and lowest trophic states respectively. Reasons
for these differences include the proportion and chemical
composition of glacial meltwater entering these lakes,
especially the phosphorus concentration.
In the second austral summer (1978-79) of the ECOLS
project, spatial and temporal changes in Lakes Fryxell and
Hoare were monitored. Preliminary findings suggest that
Lake Fryxell is more productive than Lake Hoare. An
under-ice SCUBA reconnaissance revealed an extensive
benthic, columnar algal mat community which may dominate the
biogeochemical activity in these two lakes.

DETECTION OF BENOMYL-RESISTANT VENTURIA INAEQUALIS AND PENICILLIUM SP. ON APPLES IN VIRGINIA. K. S. Yoder, Dept. of Plant Path. & Physiology, VPI & SU, Winchester Res. Lab., Winchester, VA 22601.

Benomyl-resistant strains of Venturia inaequalis and Penicillium sp. were first detected in Virginia in 1978 and in 1977 respectively, on potato dextrose agar amended with 5 µg/ml benomyl. Uninhibited spore germination and mycelial growth on this medium indicates at least a ten-fold decrease in sensitivity to benomyl compared to normal sensitive strains of the two fungi. Alternate non-benzimidazole registered fungicides are recommended for apple scab control in the Smyth County area where resistant Venturia inaequalis was isolated, and for blue mold control in Frederick County apple storages where the resistant Penicillium sp. was detected.

ISOLATION OF A PESTALOTIA SP. FROM GRAPE CANE CANKERS IN VIRGINIA. K. S. Yoder, Dept. of Plant Path. & Physiology, VPI & SU, Winchester Res. Lab., Winchester, VA 22601.

A Pestalotia sp. was isolated from two vineyards in Frederick and Rappahannock Counties, Virginia. Consistent isolation of the fungus from surface-sterilized woody cankers and green cane lesions implicates pathogenicity of an organism not previously reported from grape in Virginia.

Cross sections of woody cane cankers from which the Pestalotia sp. was isolated revealed a V-shaped penetration of the fungus into the wood. The most common green cane symptom was a slightly sunken necrotic lesion.

STUNTING OF GOLDEN DELICIOUS/M.26 APPLE TREES IN ASSOCIATION WITH RED DELICIOUS TREES EXHIBITING GRAFT UNION NECROSIS AND DECLINE SYMPTOMS. K. S. Yoder, Dept. of Plant Path. & Physiology, VPI & SU, Winchester Res. Lab., Winchester, VA 22601.

A decline of vigor of 6 yr old Smoothee Golden Delicious/M.26 apple trees was observed in the corresponding location of the tree row immediately adjacent to Red Delicious/MM 106 trees exhibiting graft union necrosis, symptoms previously associated with infection by Tomato Ringspot Virus. The proximity of the series of trees exhibiting these symptoms in adjacent rows suggests that the symptoms may be related to a common cause. Populations of Xiphinema americanum nematodes, a known vector of Tomato Ringspot Virus, were 10 per 100 cc of soil from the affected tree root zone and 29 per 100 cc of soil from the grass-alfalfa cover crop in the drive row of the orchard.

Chemistry

Fifty-seventh Annual Meeting of the Virginia Academy of Science
May 8-11, 1979, University of Richmond

THE SYNTHESIS OF AROMATIC α,α-DIFLUOROISOCYANATES.
C. B. Amann*, J. W. Thompson and A. F. Clifford. Dept. of
Chemistry, Va. Polytechnic Inst. and State Univ., Blacksburg,
Va. 24061

Carbonyl fluoride will add to a nitrile in the presence
of anhydrous hydrogen fluoride with mercuric fluoride
present as a catalyst. By this method we have synthesized
several aromatic mono and di α,α-difluoroisocyanates and
urethanes.

GROWTH OF CRYSTALS IN GELS. Toni A. Ayers* and P. G. Barber.
Dept. of Natural Sciences, Longwood College, Farmville, Va.
23901

This study is the beginning of a search for ways to grow
crystals suitable for structural studies on substances that
do not readily crystallize or that do so with imperfections
such as twinning. The methods used include modifications
of growth from solution and growth in gels.

In the usual method of growing crystals from solution
the crystal is supported by the bottom of the glass
container or by a thread suspended from the lid or from a
cobra submerged in the liquid. The latter method does
eliminate the wick effect caused by the thread, but both of
these solution methods leave a string in the crystal. An
improvement was developed which connected a seed crystal
directly to a fine glass capillary. Large, easily mounted
and manipulated crystals resulted.

To eliminate the additional problem of twinning and habit
modification by glass barriers, silicate gels were used to
grow crystals in gels. This process allows the crystals to
grow slowly and regularly.

THE STABILITY OF THE 28S-5.8S COMPLEX FROM
RAT AND CHICKEN. N. Banerjee* and T.O. Sitz. Dep't.
of Chemical Sciences, Old Dominion Univ.,Norfolk, Va.
23508.

The large subunit of eukaryotic ribosomes contains
5.8S rRNA, which is hydrogen bonded to the 28S rRNA.
This interaction occurs through the 3' end of the 5.8S
rRNA and a complementary region of 28S rRNA.Isolated
5.8S rRNA can interact to form dimers or multimers.
There is only a three nucleotide difference in the chicken
and rat sequence, however the optimum temperature for
dimer formation and stability is significantly different.
The rat dimer had a Tm about 5° higher than the chicken
dimer (Biochem. 17, 5811).

Currently we are comparing rat and chicken 28S-5.8S
complex to examine the thermal stability of these inter-
actions. In 0.15M Na$^+$, the Tm for both of them is
around 55°. In order to detect small differences in Tm,
non-radioactive chicken and ^{3}H-labeled rat complex will
be mixed and the Tm of both determined simultaneously.

PARTIAL IDENTIFICATION OF THE COMPONENTS OF THE CRUDE
LIPID EXTRACT OF CHRYSAORA QUINQUECIRRHA. Charles E. Bell,
Jr., Thomas J. Haas, and Donna L. McGovern. Dept. of
Chemical Sciences, Old Dominion Univ., Norfolk, VA 23508.

The lipid extracts of the jellyfish C. quinquecirrha
were separated by TLC and analyzed by capillary Column Gas
Chromatography. Evidence is presented which confirms
previous work that indicates prostaglandins are present.
Other lipid classes are identified.

ADDITIVE NMR CHEMICAL SHIFT PARAMETERS FOR DESHIELDED METHINE PROTONS. Deborah Bowles and Harold M. Bell, Dept. of Chemistry, V.P.I. & S.U., Blacksburg, Va. 24061.

The use of additive parameters for the prediction of NMR chemical shifts is widely practiced. However, existing correlations do not give satisfactory results when applied to highly deshielded methine protons, for these protons invariably give calculated chemical shifts which are considerably larger than the experimental values.

In this work, methine chemical shifts have been studied using multiple linear regression analysis in an effort to determine under what limiting circumstances the additivity of shift parameters can be expected to apply. A literature survey uncovered approximately 500 methine chemical shifts, 200 of which have been subjected to computer analysis. As expected, it was not possible to satisfactorily explain all methine chemical shifts with a single set of substituent parameters. However, if only the deshielded methine cases were considered (H-CXYZ, where at least two of the groups are electron-withdrawing), a much better set of parameters could be determined. Our best results thus far show a standard error of estimate of 0.27 ppm, for protons spread between 3 and 7 ppm, involving 20 different substituents.

PURIFICATION AND CHARACTERIZATION OF A SERUM MODULATOR OF IRON FLUX FROM STORAGE TISSUES. Melissa P. Calisch* and Richard W. Topham, Department of Chemistry, University of Richmond, Virginia 23173.

Strong evidence suggests that blood serum ferroxidases (ceruloplasmin and Ferroxidase II) promote the formation of $Fe(III)$-transferrin and thereby stimulate the turnover of iron from tissue stores. Ceruloplasmin is the major ferroxidase in human serum; however, Ferroxidase-II accounts for an increased proportion of the activity in less highly developed animals. A potent inhibitor of both serum ferroxidases has been isolated from whole rabbit serum and purified to homogeneity. It has been identified as a protein composed of a single polypeptide chain with a molecular weight of 6.0×10^4. Another compound of comparable inhibitory action has been identified, isolated, and partially characterized from whole human serum. Since the rabbit and human proteins inhibit both serum ferroxidases, they could serve as naturally occurring modulators of these enzymes and thus they could regulate the flux of iron from storage tissues. (This work was supported by USPHS Grant 1 RO1 AM20148 from the National Institute of Arthritis, Metabolism, and Digestive Diseases).

ON THE ISOKINETIC EFFECT. Do Ren Chang, Dept. of Chemistry, Averett College, Danville, Va., and George Sanzone, Dept. of Chemistry, VPI&SU, Blacksburg, Va. 24061
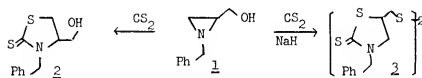
The temperature-dependencies of the rates of both unimolecular and bimolecular reactions are found to correlate. This correlation is presented in terms of a Reaction-Temperature function which should have considerable pedagogical value. Using this function, the construction of a reaction surface leads to a clear picture of the significance of linear enthalpy-entropy correlations. The existence of an isokinetic relationship will be discussed in this context.

TIME-DEPENDENT FOCUSSING OF THE TIME-OF-FLIGHT MASS SPECTROMETER. J. A. Browder and G. Sanzone. Dept. of Chemistry, VPI & SU, Blacksburg, Va. 24061

Recently, data has been collected on the focussing of a time-of-flight mass spectrometer with time-dependent fields. All of the parameters of the Impulse-Focussing-Field Theory were varied systematically. Test of the validity and practical utility of the theory as found in these studies will be presented.

THE MICROWAVE SPECTRUM OF $CH_3SiH_2PH_2$. R. O. Carter. Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, Va. 23508, and J.R. Durig, M. Jalilian, Y.S. Li, Dep't. of Chemistry, Univ. of South Carolina, Columbia, S.C. 29208.

The microwave spectrum of methylphosphinosilane has been recorded from 18.5 to 40.0 GHz. Two sets of a-type transitions have been observed and assigned with the stronger lines being attributed to the trans conformer and the weaker ones to the gauche conformer. The rotational constants obtained for the trans form are: A = 16094, B = 3904.30, and C = 3325.58 MHz and for the gauche form: A = 16048, B = 3806.07, and C = 3251.97 MHz. Splitting was observed for both sets of transitions and was attributed to the coupled internal rotation of the symmetric and antisymmetric rotors. The structural parameters needed to fit the B and C rotational constants indicate a rather short Si-P bond distance of 2.10 A. Because of the splitting it was not possible to obtain values for the dipole moments. Relative amounts of the two conformers were found to be consistent with those obtained from the vibrational study.

PHOTODEGRADATION OF POLY(N-VINYLCARBOZOLE). R. F. Cozzens and W. R. Mindak*. Dept. of Chemistry, George Mason University, Fairfax, VA. 22030.

Poly(N-vinylcarbazole) PVCz is a well known photoconductive polymer with industrial application in the electrophotographic industry. As a photoconductive material its electrical properties are controlled by certain impurities either purposely doped into the polymeric matrix, fortuitously present or produced by degradation during use or manufacture. Photoelectrical activation spectra measured in our laboratory indicate that the first, second and third excited singlet state may lead to generation of photocarriers. Photochemical degradation is found to result from the lowest triplet state of the carbazole chromophore and may be quenched by transfer of triplet energy to acceptors such as piperylene and naphthalene. Stern-Volmer plots in fluid solution indicate quenching of photooxidative yellowing by these triplet acceptors. The nature of various degradation products, their mechanism of formation and effect on photoconductivity is discussed.

AZIRIDINE – CARBON DISULFIDE REACTIONS. S. Clough, R. Solomon, E. Crews.* Department of Chemistry, University of Richmond, Virginia 23173. A. Johnson, L. Jaques* and J. Forehand, A. H. Robins Company, Richmond, Virginia 23220.

The reactions of 1-benzyl-2-hydroxymethyl aziridine (1) with carbon disulfide have been investigated under both neutral and basic conditions. The structures of the products, 2 and 3, have been assigned on the basis of spectral data which are discussed. Mechanisms for these transformations are discussed in light of the results of deuterium labeling experiments.

THE ISOLATION AND IDENTIFICATION OF A UNIQUE NATURAL PRODUCT FROM THE SEEDS AND PODS OF AILANTHUS altissima. John R. Cooper and Samuel J. Gamble, Dept. of Chemistry, Lynchburg College, Lynchburg, Virginia 24501
From the seeds and pods of Ailanthus altissima, by a systematic non-polar extraction, a saponifiable lipid has been isolated. The extraction technique has also produced a non-saponifiable solid lipid to be identified. Various other organic constituents cited in the literature pertaining to A. altissima have also been confirmed.

DETERMINATION OF FORMATION CONSTANTS FOR NUCLEOTIDE-POLYAMINE COMPLEXES. A LABORATORY EXPERIMENT. R. I. Elliott* and W. H. Voige. Dept. of Chemistry, James Madison Univ., Harrisonburg, Va. 22807
We have developed a laboratory experiment which uses an anion exchange resin method to determine the formation constants for nucleotide-polyamine complexes. The experiment, which is adapted from the work of Nakai and Glinsmann (Biochemistry 16, 5636 [1977]), is appropriate for a biochemistry or biologically oriented physical chemistry laboratory course.
Reaction mixtures, which contain an adenine nucleotide, several concentrations of putrescine, and Dowex AG1-X2, are incubated to allow nucleotide-putrescine complexation. This complex remains in solution, while uncomplexed nucleotide occurs both free in solution and adsorbed to the insoluble anion exchange resin. The total nucleotide concentration in the supernatant of each reaction mixture is determined spectrophotometrically. Treatment of these data by the graphical method of Nakai and Glinsmann, which compensates for the presence of uncomplexed nucleotide in the supernatants, yields the formation constants for the complex.

THE ANALYSIS OF S-ADENOSYLMETHIONINE AND S-ADENOSYLHOMO-CYSTEINE IN TISSUE CULTURE CELLS. K. E. Godburn*, J. M. Keller*, and T. O. Sitz. Dept. of Chem. Sciences, Old Dominion Univ., Norfolk, VA 23508.
Ribosomal RNA isolated from cancer cells has low levels of 2'-O methylation when compared to normal cells although the methyltransferases responsible for the post-transcriptional modification have elevated activities. Similar results for the base methylation of transfer RNA have been reported. One possible explanation for this paradox is that an inhibitor of the methyltransferase reaction accumulates in tumor cells resulting in hypomethylation which stimulates the tumor cells to produce excess enzymes in an attempt to compensate for the low methylation levels. The product of the methyltransferase reaction, S-adenosylhomocysteine, has been shown to have a low Ki for specific methyltransferases. It will be important to correlate the concentrations of both the substrate, S-adenosylmethionine, and the product, S-adenosylhomocysteine, with the methylation level of RNA in various tissues. These levels can be determined with either high-pressure liquid chromatography using a VYDAC cation exchanger (Virol. 89,494) or sulfopropyl Sephadex, a strong cation exchanger (Anal. Biochem. 91,516) to obtain rapid resolution and quantitative recovery of SAM and SAH from the other components. We are currently investigating the best procedure to examine SAM and SAH concentrations in a variety of tissue culture cells.

THE DETERMINATION OF TRACE ELEMENTS IN HUMAN TEETH BY PROTON INDUCED X-RAY EMISSION (PIXE). G. C. Grant, College of William and Mary (Research Campus), Newport News, Va. 23606 and L. D. Fretwell, Dept. of Community Dentistry, MCV/VCU, Richmond, Va. 23298.
Lead in human teeth has been positively correlated with environmental exposure in childhood lead poisoning but most studies have not reported the concentration of other trace elements present in the same teeth. Other trace elements have been correlated in epidemiological studies with the degree of susceptibility to dental caries. PIXE, a modern multielemental technique, was used to study all elements from aluminum (Z=13) to uranium in non-carious teeth with the finding that Fe, Zn, Sr, Sn and Pb were the most abundant trace elements. Teeth were dissected to determine elemental distributions in outer enamel, inner enamel (DEJ), secondary (root) dentine, secondary (coronal) dentine and outer dentine finding highly significant variations. Multiple extractions were also analysed to determine the elemental variation between different tooth types from the same individual, also finding highly significant variations.

MARINE STEROLS FROM THE JELLYFISH, CHRYSAORA QUINQUECIRRHA. Thomas J. Haas and Charles E. Bell, Jr., Dept. of Chemical Sciences, Old Dominion Univ., Norfolk, VA 23508.
A lipid extract of the jellyfish C. quinquecirrha was fractionated on a silicic acid column. Sterols were eluted with methanol-chloroform using a gradient from 2% to 10% methanol. Fractions were analyzed by gas chromatography. Peaks were identified by relative retention times (α) using cholesterol as an internal standard. Tentative identifications are: 22-dehydrocholesterol (α=.90), 24-methylcholesterol (α=1.30), and 24-ethylidene cholesterol (α=1.65). Also found were sterols with relative retention times of 1.10, 1.15, and 1.40. These assignments have not been made.
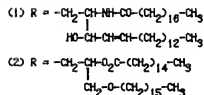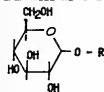
SEMINOLIPID: A POTENTIAL OPIATE RECEPTOR
MODEL. D. G. Hand*, R. L. Williams and D. Brase*,
Dep't. of Chemical Sciences, Old Dominion Univ., and
Dep't. of Pharmacology, Eastern Va. Medical School,
Norfolk, VA. 23508.

Cerebroside sulfate, CS(1), has recently been shown to
bind opiate drugs and therefore satisfy some of the re-
quirements for action as a opiate receptor.Seminolipid,
SGG (2), a novel sulfated galactoglycerolipid that can be
isolated from the testis of a variety of animals may be
viewed as a structural analog of CS. In view of this close
structural similarity, we have initiated an original study
to determine whether SGG may possess the unique opiate
binding quality of CS.

This paper will deal with the method of isolation of SGG
from boar testis and its subsequent purification and
identification by chromatographic and spectral methods.
A technique to study the opiate receptor-like action of
SGG will also be discussed.

NEW APPROACHES TO THE SYNTHESIS OF INDOLO-4,5-QUINONES. II.
Jane L. Harcus* and James B. Patrick, John Baker Daffin
Laboratory of Chemistry, Mary Baldwin College, Staunton,
Virginia 24401.

In cases where oxidation by Fremy's Salt (potassium
nitrosodisulfonate) is inapplicable the oxidation of
5-hydroxyindoles to indolo-4,5-quinones has been effected
by a variety of methods, none of which seem to be of
general applicability. We have continued our previously
reported work on nitrosation of 5-hydroxyindoles at the
4-position and now report these experiments and also
studies on an alternative: diazo coupling of 5-hydroxy-
indoles. Phase-transfer catalysis of Fremy's Salt oxid-
ation by Adogen 464 is also described.

AN IMPROVED METHOD OF COLORIMETRIC DETERMINATION
OF AMMONIUM ION Daniel J. Carucci, David H.
Harpole, Jr., Jerome E. Kahn, John C. Kisalus,
Edward U. Kissel, III, Lucien T. Megna, Michael
A. Pleva, and James K. Shillington, Dept. of
Chemistry, Washington and Lee University,
Lexington, Virginia 24450.

The most common technique for determination of
ammonia in natural waters is the Berthelot method,
or some variation of it, in which a blue color is
produced from the indophenol chromophore. Patton
and Crouch, [Analytical Chemistry, 49, (1977)],
showed that the formation and stability of the
chromaphore is very dependent on the catalyst/
ammonia ratio. We have shown that nitrite in
natural waters can react with the catalyst, there-
by affecting the catalyst/ammonia ration and re-
sulting in incorrect ammonia values. However, it
was also found that the addition of potassium
phthalate, under the proper conditions, resulted
in accurate ammonia determinations. The inherent
deficiencies of other methods for the colorimetric
determination of ammonia and the mechanism by
which potassium phthalate corrects them are dis-
cussed.

SYNTHESIS OF N,N'-DISUBSTITUTED-PARA-PHENYLENEDIAMINES.
Paul D. Henson, J. Michael Williams*, and Kenneth A. Cole*,
Dept. of Chemistry, Roanoke College, Salem, Va. 24153

Condensation reactions between aniline and p-aminophenol
(PAP) and aniline and hydroquinone (HQ) have been examined
for the preparation of N,N'-diphenyl-p-phenylenediamine.
PAP was found to be slightly superior to HQ in condensation
reactions carried out in the presence of ferric chloride
and phosphoric acid catalysts. Phosphoric acid proved to
be a poor catalyst for the reactions.

Similar reactions of PAP with aromatic amines such as
the various toluidines and xylidines were employed to
prepare a variety of N,N'-diaryl-p-phenylenediamines. (This
work was supported by Howard Hall and Co., Cos Cob, Conn.)

RECENT ADVANCES IN THE RESEARCH OF TOBACCO
FLAVOR. Robert M. Ikeda* Philip Morris Res.
Ctr., Richmond, Va. 23261

Procedures used in the isolation and
identification of the volatile flavor
constituents of tobacco are reviewed.

Investigations of Burley, Bright and
Oriental tobaccos have revealed the presence
of a number of compounds which appear to be
breakdown products of isoprenoid material.
Selected constituents identified in tobacco
and their structural relationships to
carotenoids and the diterpenoids of the
labdanoid and thumberganoid series are
discussed.

Methodology for determining the important
components of flavor are explained.

SPECTROSCOPIC CHARACTERIZATION OF CHITIN. Carolyn J.
Jewell* and James P. Wightman, Chem. Dept., Va. Polytechnic
Inst. and State Univ., Blacksburg, VA 24061

The chitinous materials, chitin, chitosan and natural
chitin have been characterized by scanning electrom micro-
scopy (SEM) with energy dispersive analysis of X-rays
(EDAX), infrared spectroscopy (IRS) and electron spectro-
scopy for chemical analysis (ESCA). The SEM photomicro-
graphs show similar surface morphology for chitin and
chitosan but different for natural chitin. All three solids
show a significant calcium EDAX signal. Transmission
infrared spectra of KBr pellets of the three chitinous poly-
mers show absorption bands unique to each material. Eight
bands in the 3600-465 cm^{-1} region were common to all three
polymers. However, natural chitin contained no peaks at
2150, 1560, 1380, 1330 and 1260 cm^{-1}. Chitosan contained
no peak at 955 cm^{-1}. Narrow scan ESCA spectra of the pow-
dered solids were obtained for the C 1s, O 1s, N 1s and
Ca 2p photopeaks. The binding energies of the N 1s and
Ca 2p photopeaks were equivalent for the three polymers.
However, the binding energy for the O 1s in chitosan was
1 ev higher than in chitin and natural chitin. [The
advice and help of Mr. Peter Perceval is acknowledged
gratefully.]

THE SYNTHESIS OF ALIPHATIC α,α-DIFLUOROISOCYANATES.
J. C. Johnson*, J. W. Thompson* and A. F. Clifford. Dept.
of Chemistry, Va. Polytechnic Inst. and State Univ.,
Blacksburg, Va. 24061
    Carbonyl fluoride is a by-product formed in the reaction
of fluoroformylimino sulfur difluoride and silver
difluoride. We have attempted to find a use for carbonyl
fluoride and have found that it will react with nitriles in
the presence of anhydrous hydrogen fluoride. This reaction
is exceedingly slow; however, it can be accelerated by use
of a catalytic amount of mercuric fluoride. Employing this
method, we have synthesized several new aliphatic mono and
di α,α-difluoroisocyanates.

VIBRATIONAL SPECTRA OF SEVERAL BARBITURATES AND BARBITURATE
ANALOGUES. Carol Karnas and R. O. Carter. Dept. of Chem.
Sciences, Old Dominion Univ., Norfolk, VA 23508.
    It was the purpose of this study to investigate a method
with potentially greater specificity than presently used
techniques in differentiating between various illicit drugs
and their isomers. Raman spectroscopy was chosen because
of its selectivity and sensitivity which can equal or exceed
that of infrared spectroscopy.
    Willis, Cook and Jankow have used this tool for the dif-
ferentiation of various barbiturates. Confirmation of some
of their work has been obtained in this study. The spectra
of several of the same barbiturates were obtained using a
Spex Laser Raman Spectrometer. In addition frequencies have
been recorded so that more exact correlations could be made.
    Group frequencies among the barbiturates will be discussed
In order to further characterize the group frequencies among
the barbiturates, vibrational assignments of the Raman and
infrared frequencies of the symmetric molecules, isocyanuric
acid and barbituric acid will be made, hopefully in time for
the conference.

TRACE AMINE ANALYSIS OF BIOLOGICAL SAMPLES USING HPLC.
R. L. Williams and Thais Keegan, Department of Chemical
Sciences, Old Dominion Univ., Norfolk, VA 23508.
    Phencyclidine (PCP) is an anesthetic with psychotomimetic
properties which has gained increased interest since its
appearance as an illicit street drug. Attempts to explain
the prolonged effects of the drug as a function of its blood
and tissue levels have been inconclusive. Evidence suggests
that PCP is a competitive inhibitor of biogenic amine uptake.
Previously, analyses have been limited by detection capa-
bilities. A reverse-phase HPLC procedure allows separation
of the o-phthalaldehyde derivatives of 18 biogenic amines
and polyamines on a μ Bondapak/^{C}18 column using methanol-
acetic acid as the mobile phase. Using 3,4-dihydroxybenzyl-
amine as an internal standard, levels as low as 100 pico-
grams can be quantitated by continuous-flow fluorescence mon-
itoring of the eluate.
    Comparative changes in biogenic amine levels in rat brain
can be monitored as a function of time and of drug dose for
PCP and selected analogues. In addition, the interrelation-
ship of the amines in the central nervous system can be
studied.

PREDICTING THE PRODUCTS OF INORGANIC REACTIONS – AN EXAM-
PLE OF CADAI. Jerry P. Keilsohn, James J. Leary, and Frank
A. Palocsay. Dept. of Chemistry, James Madison University,
Harrisonburg, Va. 22807
    Two CADAI programs, giving general chemistry students
practice in predicting the products and direction of simple
inorganic reactions, are described. These augment a lec-
ture-laboratory assignment presently in use at James Madi-
son University.[1] The first program requires that the
student predict the products and direction of a series of
randomly generated reactions. This program makes correc-
tions in student generated results and offers aid. The
second program repeats the process for oxidation, reduction
reactions. These programs are written in BASIC and imple-
mented on an OSI C2-8P disk based microcomputer.

[1] Palocsay, Frank A., and Leary, James J., ACS MARM,
    April, 1977.

BACTERIAL MEMBRANE ELECTRODE FOR THE DETERMINATION OF NI-
TRATE. R. K. Kobos, D. J. Rice*, and D. S. Flournoy*. Dept.
of Chemistry, Virginia Commonwealth Univ., Richmond, Va.
23284
    A novel potentiometric sensor has been developed for ni-
trate by coupling the bacterium Azotobacter vinelandii with
an ammonia gas-sensing electrode. Nitrate is reduced to am-
monia by a two step process involving the enzymes nitrate
and nitrite reductases contained in the bacterial cells.
The ammonia produced is detected by the gas-sensing elec-
trode. The response of the resulting bacterial sensor is
linear over the concentration range of 1×10^{-5} to 8×10^{-4}
M with a slope of 50 mV/decade. There was no indication of
deterioration of this response after a period of two weeks
when the electrode was stored in the growth medium. Se-
lectivity studies were performed by testing the response of
the electrode to inorganic ions and organic nitrogen-con-
taining compounds. Nitrate containing samples were analyzed
with an accuracy and precision between 3 to 4%. The ad-
vantages of using intact bacterial cells to mediate a multi-
step enzymatic process requiring cofactors are clearly dem-
onstrated. (Aided by grants from Research Corporation and
Virginia Commonwealth University Grants-In-Aid for Faculty)

CHEMISTRY RESEARCH IN AN INDUSTRIAL ENVIRONMENT.
George P. Koch*, Metallurgical Research Division,
Reynolds Metals Company, Richmond, VA 23229
    Research in an industrial environment may be
described as a search for solutions. The fields
of chemistry that are applied in the operations
of a large primary metals producer are discussed
in terms of research in those fields and particu-
lar problems requiring a competence in those
areas.

THE CHANGING ENVIRONMENT OF PHARMACEUTICAL RESEARCH. Carl D. Lunsford. A. H. Robins Company, Inc., Richmond, Va. 23220

Many factors are bringing change to the methods of chemical and related scientific research in the pharmaceutical industry. These include increased government regulations, improvement in instrumentation capability and sensitivity, expanding knowledge of the biochemical basis for disease, and the general advancement of the sciences.

Resulting negative trends are rapidly increasing costs, longer time cycles for new drug introduction, unavailability of certain products to the public, and the relocation of research efforts. On the positive side, the quality and documentation of industrial research, and hence the credibility, are improving. There is a safer laboratory environment. Increased emphasis on short term project and target oriented research are resulting in the development of therapeutically significant new drugs.

These factors are discussed from the view of research management of a moderate size pharmaceutical company.

SIMULATED CHRONOAMPEROMETRY – AN EXPERIMENT IN COMPUTER GRAPHICS. J. G. Mason and H. M. Bell, Dept. of Chemistry, Va. Polytechnic Inst. and State Univ., Blacksburg, Va 24061.

An simulated experiment has been developed for use in the undergraduate laboratory to demonstrate the technique of chronoamperometry. The experiment includes 1) Concentration-time profiles for diffusion, 2) Concentration-distance profiles, 3) "Wiring" the apparatus and setting the parameters to yield representative current time curves which can be measured and hard copied. The final step involves hand calculation of the data.

MODIFICATION OF DRUGS, DRUG PRECURSORS, AND NATURAL PRODUCTS WITH PENTAFLUOROSULFANYL ISOCYANATE. J. F. Matt* and A. F. Clifford. Dept. of Chemistry, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

The introduction of fluorine or fluorinated groups into pharmaceutical products has resulted in modification of the compounds' biological activity. For example, 5-fluorouracil is an effective antitumor agent, whereas, uracil itself has no such effect. We have found that the pentafluorosulfanyl group can be introduced into a variety of drugs and drug precursors by the reaction of pentafluorosulfanyl isocyanate with hydroxyl, amino, or carboxylate functionalities.

THE ANALYTICAL PROBLEMS OF POTTERY ANALYSIS William H. Matthai, Jr. and Michael A. Pleva, Dept. of Chemistry, Washington and Lee University, Lexington, Virginia 24450.

Several methods of qualitative analysis of both pottery and glazes were investigated. Emission spectroscopic, polarographic, and differential pulse stripping voltametric methods will be discussed and compared. Work is now continuing in the area of quantitative analysis by the differential pulse stripping method. Progress and problems to date and further possibilities and plans will also be mentioned.

THE PREPARATION OF SOME INTERESTING RUTHENIUM(II) COMPLEXES. Daniel J. Nardi, Stephen A. Hackney, and Frank A. Palocsay. Dept. of Chemistry, James Madison University, Harrisonburg, Va. 22807

A series of Ruthenium (II) complexes of the general formula RuB_2L_2 (B=2,2´-bipyridyl, L=H_2O,Cl, or an aromatic amine) have been synthesized using two different routes.[1-3] Two isomers of each complex have been isolated. Spectral interpretation and electrochemical studies of the reaction products leads us to propose cis and trans geometrys for the isomer pairs.

[1] Krause, R. A., "Synthesis of Mixed Complexes of Ruthenium(II) with 2,2´-bipyridyl," Inorganica Chimica Acta, 22 (1977) 209-213.
[2] Johnson, E. C., Ph.D. Thesis, U.N.C. Chapel Hill, 1975.
[3] Meyer, T. J., et al, unpublished results.

DEVELOPMENT OF NEW OR IMPROVED PROCESSES FOR SYNTHETIC FIBERS. J. H. Newland and R. A. Lofquist. Fibers Division, Technical Center, Allied Chemical Company, Petersburg, Virginia.

The growth rate in production and consumption of synthetic fibers throughout the world continues to be the fastest of all chemical products. The continuing effect of this growth to meet the needs and wants of the public and to meet competition between fiber producers is both process and product obsolescence.

The future position of the textile industry will depend on synthetic fiber expansion via economical processes and introduction of new products. Therefore effort continues to be aimed at process and product improvements. Since new equipment is required for process modification the future of the fiber production machine industry is tightly interwoven with that of the fiber producer. This presentation will describe briefly the development of new or improved processes and products for apparel, home furnishing and industrial yarns. These advances allow the synthetic fiber producer to continue to expand rapidly despite rising energy and labor costs.

CYCLIC QUATERNARY AMMONIUM POLYMERS. Raphael M. Ottenbrite and William Ryan, Dept. of Chemistry, Va. Commonwealth Univ. Richmond, VA 23284

As part of our study involving the synthesis of anionic and cationic polyelectrolytes we have developed a new cyclocationic polyelectrolytic system by the 1,3-polymerization of N,N-dimethyl-2,3-dimethylenepyrrolidinium bromide. This polymer has a five-membered pyrrolinium ring in the backbone of the polymer chain.

The first polymer obtained from this system exhibited intrinsic viscosities of only 0.8-1 dl/g. Performance evaluation of this polymer were made by comparing it to commercial Cat-Floc on a 50 ppm montmorillonite clay suspension using the method of Black and Vilaret. Samples of our polymer in the test had intrinsic viscosities of less than 1 dl/g, while that of the Cat-Floc[R] was 1.2 dl/g. Floc times and residual turbidities, though not as good, were comparable to Cat-Floc[R]. Buchner funnel tests to determine activated sludge dewatering performance were made with better results than with Cat-Floc.

Since these tests, we have greatly increased the molecular weight of our N,N-dimethylpyrrolidinium bromide polyelectrolyte to as high as 4.0 dl/g. We have also determined the effect of additives such as salts, oxygen, initiators, concentration and inhibitors. It is apparent from these studies that this polymer greatly exceeds the molecular weight obtained by any other cationic polymer system and that its potential utility should be commensurate. We have also conducted studies to elucidate the cyclic structure of Cat-Floc[R].

THE ESSENTIAL ARGINE RESIDUE IN THE ACTIVE SITE OF CHICKEN MUSCLE PYRUVATE KINASE. Evelyn A. Pratt* and James H. Yuan, Dept. of Chem. Sciences, Old Dominion University, Norfolk, VA 23508.

Pyruvate kinase purified from chicken breast muscle is inactivated by incubation with 2,3-butanedione in 50mM MOPS-borate buffer (pH 7.5) and 25°. The rate of inactivation is linearly dependent upon the concentration of 2,3-butanedione with a second-order rate constant of 0.015 M^{-1} min^{-1}. Very little activity is lost when modification is performed in the presence of phosphoenopyruvate. Protection against 2,3-butanedione inactivation is also provided by Mn-ADP and Mg-ADP. The interaction of 2,3-butenedion with arginyl residue in the active site of several pyridine nucleotide and adenine nucleotide dependent enzymes has been reported. The data obtained in these studies suggest that an arginyl residue plays an essential role in the enzymetic mechanism of pyruvate kinase. The details of arginyl residue modification and the inactivation of pyruvate kinase will be presented.

MULTIPLE METHODS FOR THE ANALYSIS OF 2'-O-METHYLATION IN 5.8S rRNA. S. G. Ryan* and T. O. Sitz. Dept. of Chemical Sciences, Old Dominion Univ., Norfolk, VA 23508.

The 5.8S rRNA molecule contains two ribose methylated positions. One of the methylated nucleotides, a uridine residue at position #14, is a partial methylation. In tumor cells the uridine residue is 20% methylated compared to 70% in normal tissue. In the sequence analysis of the 5.8S rRNA molecule a pancreatic digest was followed by separation of the fragments on a two-dimensional Sanger map. Although this is a reproducible method for determination of the level of methylation of the uridine residue the procedure is too tedious and time-consuming to use for the analysis of many samples. We are currently comparing several methods which will allow us to run several samples simultaneously and get reproducible results. These methods include a two-dimensional cellulose tlc separation of digested nucleotides (Biochem. 14,1956), one-dimensional paper electrophoresis on DEAE in 7% formic acid, one-dimensional paper electrophoresis on Whatman 3mm at pH 3.5, and one-dimensional paper electrophoresis on DEAE at pH 3.5. The results of these comparisons will be reported.

GETTING MORE THAN MOLECULAR GEOMETRIES FROM X-RAY DIFFRACTION. Wayne H. Pearson* and Fred K. Ross. Dept. of Chemistry, Va. Polytechnic Inst. and State Univ., Blacksburg Va. 24061

X-ray diffraction techniques have long provided a means to determine molecular geometries in the solid state. In addition to the location of atomic positions, information is contained in the x-ray intensities concerning the electron densities and, therefore, the electronic charges on atoms in a compound. Unfortunately, this information cannot be obtained directly from the intensities since relative phase relationships are lost in the measurement. As a result, it is necessary to refine a model which approximates the electron distribution.

The discussion will emphasize the spherical atom approximations for modeling electron distributions about atoms and computing local ionic charges. In addition, the x-ray minus neutron method for constraining x-ray refinements and qualitatively displaying valence electron distributions will be described.

NEW HETEROCYCLIC SEMICARBAZONE AND THIOSEMICARBAZONE ANTI-TUMOR AGENTS. Adriene Y. Principe*, R.L. Williams, Dept. of Chemical Sciences and L. Wolfenbarger, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, VA 23508.

A number of α-(N)-heterocyclic formylthiosemicarbazones have been synthesized and evaluated for antitumor(AT)activity in a variety of transplanted animal tumor systems. One of the earliest and most effective AT agents in this class of compounds was the 2-formylpyridine thiosemicarbazone. The generally accepted mechanism of action suggests that this class of compounds primarily blocks DNA synthesis in tumor cells by inhibiting the enzyme ribonucleotide reductase. This results either by chelation of the compound with the enzyme dependent ferrous ion or through the involvement of a preformed metal chelate which inhibits reductase activity.

Due to the reported toxicity of many of the compounds examined thus far, we have extended the search for effective AT agents in this class to the semicarbazone and the thiosemicarbazone derivatives of the di-2-pyridyl ketone and the 1,8-diazafluorenone ring systems.

The discussion will include the synthesis and characterization of these compounds and their quaternary salts, as well as preliminary data which suggests potential AT activity against Ehrlich ascites tumor cells in mice. The potential activity was determined by the in vitro incubation of the agents with tumor cells and subsequent monitoring of weight change in mice after injection of the treated cells.

FURTHER STUDIES ON THE NENITZESCU SYNTHESIS OF 5-HYDROXY-INDOLES. Elizabeth K. Saunders* and James B. Patrick, John Baker Daffin Laboratory of Chemistry, Mary Baldwin College, Staunton, Virginia 24401.

We have previously reported that the Nenitzescu synthesis of 5-hydroxyindoles can often be effected most conveniently at room temperature in nitromethane as a solvent. In these reactions, the use of methyl β-aminocrotonates instead of the more commonly used ethyl esters leads to dramatic improvements in yields, often exceeding 90%. A bimolecular face-to-face electron transfer complex was postulated as the critical intermediate in the Nenitzescu reaction to account for these findings. We now report new work which extends and amplifies the earlier observations.

ALKYLATION STUDIES ON 6-ETHYL-2,3-DIHYDROTHIAZOLO [3,2-a]
PYRIMIDIN-5,7-DIONES. Ernst M. Schubert,* R. G. Bass, Depart-
ment of Chemistry, and Richard A. Glennon, Department of
Pharmaceutical Chemistry, Va. Commonwealth Univ., Richmond,
Va., 23284

The title compound 1 undergoes alkylation with ethyl io-
dide or ethyl sulfate at the 7-position yielding the O-ethyl-
ated product 2a rather than 6,6-diethyl product 3 as reported
previously. Reaction of 1 with mesyl chloride gives 2b
which on reaction with K$_2$CO$_3$ in absolute ethanol also gives
2a. Treatment of 1 with POCl$_3$ gives 2c which on reaction
with K$_2$CO$_3$ or NaOEt in ethanol produced a mixture from which
no 2a was isolated.

2a, G = EtO-
2b, G = CH$_3$SO$_3$-
2c, G = Cl-
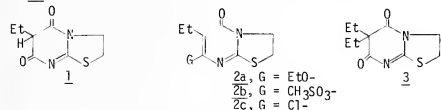
Authentic 3 was prepared by the reaction of 2-aminothiazoline
with diethyl ethymalonyl chloride in THF containing triethyl-
amine or by the reaction of 5,5-diethyl-2-thiouracil with ex-
cess 1,2-dibromoethane. This work was supported in part by
NIH Grant #9815-3409.

MAGNETIC CIRCULAR DICHROISM OF HYPERSENSITITIVE BANDS OF Nd
(III) AND Er(III). J. Scrivener and D. D. Shillady, Dept.
of Chemistry, Va. Commonwealth Univ., Richmond, VA 23284

The hypersensitive transitions of Nd(III)(^{4}G^5/$_2$ ← ^{4}I^9/$_2$
at 578nm) and Er(III)(^{2}H^{11}/$_{12}$ ← ^{4}I^{15}/$_2$ at 521nm and ^{4}I^{15}/$_2$
at 379nm) have been studied by magnetic circular dichroism
for the chlorides, acetylacetonates (AcAc) and ethylenedia-
minetetracetates (EDTA). In contrast to minor changes in
the absorbance spectra, these bands show enormous changes
upon ligand substitution. The 578nm Nd(III) band and 521nm
Er(III) band are sufficiently detailed and sensitive to
ligand environment that simple fingerprinting of ligands is
possible.

THE RATE OF QUENCHING OF SINGLET EXCITED STATE OXYGEN BY
IODINE. F. E. Scully, Jr., Dept. of Chemical Sciences, Old
Dominion Univ., Norfolk, VA 23508.

We have previously shown that iodine reacts with potas-
sium superoxide in dry benzene to form singlet excited state
oxygen which can be trapped with diphenylisobenzofuran. Less
reactive trapping agents are unable to intercept the singlet
oxygen formed. It appears that iodine, which oxidizes the
superoxide to singlet oxygen, quenches the singlet oxygen it
helps to form. We have confirmed this with studies on the
quenching by iodine of the reactions of singlet oxygen with
triphenyloxazole and with tetracyclone. Methods and problems
of estimating the rate of quenching from this data will be
discussed. Determination of the quenching constant by
changes in the fluorescence intensity of diphenylisobenzo-
furan has been made and will be compared with estimates.
The significance of this data on the ability of iodine to
photosensitize the formation of singlet oxygen will be dis-
cussed.

THE DISCOVERY OF A NEW CLASS OF RIBOSE METHYLATION IN
RIBOSOMAL RNA. T. O. Sitz, Chem. Sci. Dept., Old Dominion
Univ., Norfolk, VA 23508; K. D. Somers, Microbiol. Dept.,
E.V.M.S., Norfolk, VA 23501; R. N. Nazar*, R. N. Bot. and
Genetics Dept., Univ. of Guelph, Guelph, Ontario (CANADA).

The mammalian 5.8S rRNA contains two 2'-O-ribose methyl-
ated positions in its sequence. Position 14 contains a
partially modified uridine (UmG) which was found to vary
from 0.15 to 0.85 molar amounts in a variety of tissues
with the lowest yields in cancer cells. The other methyl-
ation is found in a guanosine at position 77 (GmC) which
remains completely modified in all tissues examined.
Earlier results had shown that this GmC position was com-
pletely modified in the 45S precursor in the nucleus. How-
ever, recent results have shown that the UmG position that
is hypomethylated in cancer cells is modified in the cyto-
plasm. This modification in position 14 also affects the
hydrodynamic shape allowing for a more open conformation.
This cytoplasmic modification may play an important role in
controlling the function of this RNA in protein synthesis.

THE REGIOSELECTIVE 3-ALKYLATION OF PIPERIDINE VIA THE
CYCLIC ENAMIDE. R. D. Todd* and F. E. Scully, Jr., Dept. of
Chemical Sciences, Old Dominion Univ., Norfolk, VA 23508.

Δ^1-Piperideine (I) is an unstable imine which possesses
unusual reactivity. Recently, we reported that alkyllithium
reagents can add to the imine carbon, but that Grignards
cannot. We now wish to report that Grignard reagents gen-
erate enamide anions by abstraction of a proton α to the
imine carbon. Alkylation of the 3-position of the piperi-
dine ring can be accomplished by addition of an alkyl ha-
lide. We have used this technique in conjunction with
either alkyllithium or lithium aluminum hydride reduc-
tion to generate 3,3-dialkyl- or 2,3-dialkylpiperidines.
Conditions and limitations of the reaction will be discussed.
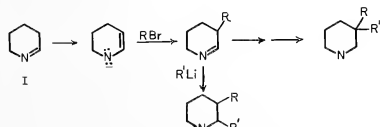
RATES OF PRODUCTION OF SINGLET AND TRIPLET METHYLENE FROM
THERMOLYSIS OF KETENE. Carl Trindle and Nevzat Aktekin,
Dept. of Chemistry, Univ. of VA, Charlottesville, VA, 22901,
and Teorik Kimya Bolumu, Orta Dogu Teknik Universitesi,
Ankara, Turkiye

The detailed potential surfaces for the thermally-in-
duced dissociation of ketene to carbon monoxide and singlet
and triplet methylene are generated by MINDO/3 computation.
An analytical expression is fit to the computed surfaces, and
used to estimate the relative rate of production of singlet
and triplet methylene. Both statistical and Morte Carlotro-
jectory studies are employed to estimate rates. The central
question addressed in this work is whether it is more pro-
bable that spin is conserved in the initial dissociation
and that the triplet methylene is formed after many subse-
quent collisions; or whether the more stable triplet methy-
lene can be produced during the initial dissociation. If
the latter is possible, a re-interpretation will be required
of the data on which Skell's rules for singlet-triplet
methylene reactively are based.

A CONVENIENT AND RAPID QUALITATIVE TEST FOR ACETAMINOPHEN IN URINE. Janine F. Twigg*, Karl F. Menk*, and James B. Patrick, John Baker Daffin Lab. of Chemistry, Mary Baldwin Col., Staunton, Va. 24401 and Lab. of Pathology, King's Daughters' Hosp., Staunton, Va. 24401

Numerous reports from Great Britain and Europe describe serious, often fatal, effects from overdoses of acetaminophen. As use of this drug increases in the U.S. there is need for a simple and rapid method for detection of acetaminophen in urine, particularly because promptness is crucial in initiating treatment for overdose. We have developed a test for emergency room use involving thin-layer chromatography of a urine extract and visualization of the acetaminophen spot by a color test with diphenyl-picrylhydrazyl, a stable free radical. The test can be run in duplicate in 15 minutes, is highly specific for acetaminophen, and will detect levels as low as 4 ppm. The normal therapeutic dose of acetaminophen is detectible up to nine hours after ingestion. Tetracycline interferes by giving a false positive, but can be easily differentiated by its fluorescence under ultraviolet illumination. The reliability of the test has been checked by a double blind procedure on 36 specimens.

NMR Studies of the Monovalent Cation Site in Pyruvate Kinase. Jeanne M. VanDivender and Charles M. Grisham, Department of Chemistry, University of Virginia, Charlottesville, Virginia.

The monovalent cation site of rabbit muscle pyruvate kinase has been examined in a series of lithium-7 NMR studies. Interactions between enzyme-bound Li^+ and substitution-inert, paramagnetic CrATP at the ATP site of the enzyme have been used to determine Li^+-Cr^{3+} distances at the active site. Thus the increase in $1/T_1$ for the Li^+ nucleus caused by enzyme-bound CrATP in the absence of substrates is consistent with a Li^+-Cr^{3+} distance of 4.9 Å.. Binding of pyruvate has no effect on this distance. Mg^{2+}, which can bind to a divalent cation site distinct from the CrATP site, increases the Li^+-Cr^{3+} distance to 6.0 Å, both in the presence and absence of pyruvate.

These distances can be combined with 15 other distances obtained from paramagnetic relaxation studies on this enzyme to yield a model of the conformations and arrangement of bound substrates and activators on pyruvate kinase.

MICROCOMPUTER-AIDED POLAROGRAPHIC ANALYSIS. John S. White, Mark F. Cheek, and Frank A. Settle, Jr., Dept. of Chemistry, Virginia Military Institute, Lexington, VA 24450.

A project involving interfacing a small Intel 8080 microcomputer system (E and L Instruments, Inc., Mini Micro Designer) to a Princeton Applied Electronics Model 174A Polarograph is described. A Keithley Model 160 digital voltmeter is used to convert analog data from the polarograph to digital data which is then latched onto the computer input bus. The computer system collects and stores data from routine differential pulse polarographic scans, identifies sample components by comparison to previously stored peak potentials, and performs quantitative analysis on each component using stored calibration data. A Lear Siegler Adam-3A video terminal is used to input parameters required for the analysis of data and to output results. The design of both hardware and software components of the system are outlined and the results of typical analyses are presented.

NEW ACETYLCHOLINESTERASE REACTIVATORS. R. L. Williams and Andrea Lunsford, Dept. of Chemical Sciences, Old Dominion Univ., Norfolk, Va. 23452

The search for new reactivators of phosphorylated acetylcholinesterase has intensified over the past years due to the introduction of a variety of potent enzyme inhibitors in the form of organophosphorous pesticides (PF) and nerve gases. The general mechanism of such inhibition can be shown as:

$$AChE \ + \ PF \longrightarrow AChE \cdot P \ + \ F^-$$
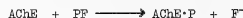
Reactivation of the inhibited acetylcholinesterase (AChE·P) has been demonstrated with only a very limited number of organic compounds, the best of these being 2-PAM, a heterocyclic oxime.

We wish to report the synthesis, characterization, and preliminary activity data of a series of bipyridyl and 1,8-diazofluorenone derivatives which appear to have reactivation potential for acetylcholinesterase, and which are currently being evaluated for reactivation activity.

MORE ON COMPUTERS IN CHEMISTRY. John H. Wise, Dept. of Chemistry, Washington and Lee University, Lexington, Virginia 24450

A new time-sharing computing system has been installed at Washington and Lee. On this system, programs which formerly were entered from paper tape are now disc resident and accessed on CRT terminals. The department maintains a dial-up terminal, and a number of hard-wired terminals are available on campus for essentially twenty-four hour use. The department continues to offer instruction on the use of the terminals and on elementary BASIC programming, with some problem assignments. Many of the former programs have been modified and adapted to the new system, and many new programs have been developed for optional use by students. A graphics display terminal will shortly be available for additional applications.

Experiences with the new system and descriptions of some of the recently developed programs will be presented. Of special interest are programs in kinetics and in qualitative analysis.

PURIFICATION AND CHARACTERIZATION OF MOLECULAR COMPONENTS INVOLVED IN THE INTESTINAL ABSORPTION OF IRON. James H. Woodruff* and Richard W. Topham, Department of Chemistry, University of Richmond, Virginia 23173.

An enzyme system capable of promoting the incorporation of iron into transferrin has been isolated from rabbit intestinal mucosa. Ultrafiltration studies indicate that the intestinal enzyme system is composed of a heat-labile protein and a small, heat-stable cofactor. The protein component and cofactor can be separated by gel-filtration and further purified by additional gel-filtration and ion-exchange chromatography. The ultraviolet spectrum, fluorescence spectrum, and mobility on TLC of the purified cofactor are identical to those of xanthine. Furthermore, authentic xanthine can be substituted for cofactor and cofactor preparations will serve as substrate for xanthine oxidase. The purified intestinal enzyme differs structurally and kinetically from ceruloplasmin and xanthine oxidase. By promoting the incorporation of iron into transferrin, this intestinal enzyme could serve a similar function in iron absorption as ceruloplasmin serves in iron mobilization. (Supported by USPHS, NIH Grant 1 RO1 AM 201-48-01; a grant-in-aid from Research Corporation, and faculty and undergraduate grants from the University of Richmond.)

Education

**Fifty-seventh Annual Meeting of the Virginia Academy of Science
May 8-11, 1979, University of Richmond**

A COLLEGE COURSE: ENERGY: PERSPECTIVES AND CONSUMER SERVICE. C. James Bier Dept. of Chemistry Ferrum College Ferrum, Virginia 24088

This paper presents the experience with and design of a course which treats energy supply and use on international, national, and local levels. Emphasis is on practical evaluation of energy use in specific consumer situations with the goal of saving money for the consumer and energy for our posterity. The course objective is to prepare the student to perform energy analyses for individuals and small businesses emphasizing the built environment and to make and explain recommendations for improving energy conservation and efficiency. The student is also given the background to explain the recommended conservation measures in terms of the greater social and economic context. The course includes a laboratory - field experience component.

DEVELOPING GOALS AND OBJECTIVES FOR THE MIDDLE SCHOOL SCIENCE PROGRAM J. D. Exline, Dept. of Education, P.O. Box 6 Q, Richmond, VA 23216

Due to concerns expressed about the intermediate/junior high school science programs, the Science Service of the VA Dept. of Education is developing goals and objectives for a middle school science program. These goals and objectives, directed towards grades six, seven, and eight, are the foundation and the beginning of a comprehensive statewide effort aimed at addressing the expressed concern. Also the middle school science program is the initial step in providing better articulation of a K-12 science program under the umbrella of the Standards of Quality, NSTA Guidelines for Science Education, and the Science Service Five Year Plan.

Focusing upon the research concerning the characteristics of the adolescent child, a statewide middle school committee has spent the past several months developing goals and objectives which it feels will better address the science education needs of this age group of students. The re-affirmation of the need for more and better types of laboratory experiences, the need to develop content around behavioral and conceptual themes, and the need to make the content of science more relevant for this age group by providing knowledge of its application to energy-environmental concerns are part of the committee's recommendation.

Public presentation of the first draft is being used to get suggestions for the final revision. This draft will be modified by the middle school committee on the basis of feedback suggestions and comments.

DESIGNING A FACULTY MERIT PAY SYSTEM: THE IMPERATIVE PRELIMINARIES. J.P.B. O'Brien, Dept. of Psychology, and D. M. DiCroce*, Dept. of English, Tidewater Community College, Virginia Beach, VA 23456

Before the costly investment of time, talent, research, development, and marketing, a merit pay system initiative requires some difficult preliminary work. Answers to the following questions will determine the quality and viability of the approach or whether or not the issue should be seriously approached at all: (1) Why have merit pay? (2) How will merit pay be funded? (3) Who is the prime mover of a merit pay concept? And why? (4) Who of the administration is committed to, or likely to become committed to, a merit pay concept? And how sincere is this commitment? (5) How should the degree of commitment affect a construction of a ranking system for merit pay? (6) What harsh realities demand recognition when attempting to build upon existing evaluation methods or initiate new methods? (7) What predictions can be made about the degree of sincere faculty commitment to a merit pay/evaluation system? How will such predictions affect development and/or implementation of the entire system? (8) Can the system be simulated before it is actually implemented? (9) Will the system be static or evolving? (10) Are there effective mechanisms for system evaluation by the evaluatees and the evaluator? The answers to these questions should indicate the scope and permit the initiation of an appropriate design.

LIQUID-LIQUID ION EXCHANGE--A DEMONSTRATION FOR THE CLASSROOM. E. M. Hairfield. Mary Baldwin Col., Staunton, Va. 24401

The selective recovery, purification, and concentration of copper values from leach liquors with liquid ion exchangers has received broad interest throughout the copper industry. This paper discusses the chemistry of these processes and presents a classroom demonstration and "research style" activities for better students. Inclusion of this material in general chemistry or physical chemistry classes would greatly enhance the students' understanding of industrial applications of equilibrium principles and of the relationship of technology to science.

THE AVAILABILITY AND USE OF SCIENCE PUBLICATIONS BY
VIRGINIA SECONDARY SCIENCE TEACHERS. Franklin D. Kizer,
Virginia Supervisor of Science, Retired, Route 2, Box 637,
Lancaster, Virginia 22503.

A random sample of Secondary Science Teachers in the
Virginia public schools was taken in 1975 to determine
what science publications were available and which were
considered most effective in assisting teachers to keep
updated with scientific knowledge and classroom techniques.
THE SCIENCE TEACHER AND THE AMERICAN BIOLOGY TEACHER were
reported as being the most useful. THE VIRGINIA JOURNAL
OF SCIENCE was only reported by one teacher.

The Education Section is challenged to contribute to
making THE VIRGINIA JOURNAL OF SCIENCE a more useful
publication to our Virginia Secondary Science Teachers.

OVERCOMING MATHEMATICS ANXIETY, Leatrice A. Kaplan and Betsy
H. Little. John Tyler Cmnty. Col., Chester, Va. 23831.

Recently there has been much interest in the understand-
ing and treatment of mathematics anxiety. The purpose of
this paper is to discuss some of the causes of mathematics
anxiety and to suggest some techniques for coping with the
fear and avoidance of mathematics.

As with other stressful occurrences, the fear of mathe-
matics is basically a feeling of not being in control of the
problem or situation. The language and symbolism are mysti-
fying. The procedures and rules appear inconsistent. There
is a general belief that one needs a mathematical mind to
solve word problems. These things and more are the sources
of mathematics anxiety.

In modern society, it is inescapable that mathematics has
become essential in the communication of information. The
mathematically disabled person will become increasingly dis-
advantaged as a citizen and in choosing a career. Thus, it
is important to deal with the feelings of mathematics
anxiety in order to aid the learning or relearning of basic
skills. Some suggestions for coping with anxiety are group
desensitization workshops, taking basic level courses, and
training by doing puzzles and various mathematical exer-
cises every day. Through understanding and management, the
fear of mathematics can be overcome to a point that the
individual can get over the barrier of not being able to
do the next math problem.

PROBLEM SOLVING STRATEGIES OF SIXTH GRADE STUDENTS WHO ARE
SUPERIOR PROBLEM SOLVERS. A. MANDELL. Dept. of Curriculum
and Instruction, Old Dominion Univ. Norfolk, Va. 23508.

A sample of 25 sixth grade level students who had been
identified as superior problem solvers were administered
six problems to solve during an audio-taped interview/pro-
blem solving session. The problems selected required a
variety of problem solving behaviors and strategies. Type-
written scripts were made from each subject's tape and the
responses made by the student in solving each problem were
categorized according to a predesigned Problem Solving Be-
haviors classification scheme. The time for completion of
each problem and an Efficiency Index (EI) (the number of
statements per second) were determined for each student on
each problem.

Spearman rho correleation values were determined for
each set of students who successfully solved each problem
- EI versus percentage use of each of 11 problem solving
behaviors. The resulting coefficients were used to define
the most effective problem solving strategy employed by
the set of students who successfully solved each problem.

The students who successfully solved the set of problems
showed evidence of formal thinking patterns, as described
by Piaget.

INVESTIGATION OF HIGH PRIORITY COMPETENCIES FROM INSTRUC-
TION IN ANY SECONDARY SCHOOL SCIENCE. A. Mandell. Dept. of
Curriculum and Instruction, Old Dominion Univ. Norfolk, Va.

A comparison of the priority rankings assigned by two
samples; (1) the Virginia Science Supervisors Association
membership (2) 250 randomly selected secondary school sci-
ence teachers from Virginia high schools, to a list of pos-
sible competencies to be expected of students who have
taken any secondary school science, was made.

Mean priority rankings and standard deviations for each
of the listed competencies in five categories were deter-
mined for each sample. Spearman rho correlation coeffi-
cients between the priority rankings of each sample were
made in each category.

Rho values of +0.945 for General Competencies,+0.74 for
Specific Competencies, +0.73 for Subject Area Competencies,
+0.67 for Values Competencies, and +0.54 for Attitude Com-
petencies were obtained, showing good agreement between the
two samples on the priorities of secondary school science
instruction.

The following were the competencies that received highest
consensus priorities. Learning to use rational thought pro-
cesses. Learning how to attack new problems. Decision mak-
ing processes. Reading for understanding. Drawing conclu-
sions. Being open-minded. Requiring sufficient data for de-
cision making. Respecting the rights and property of other
individuals. Conservation. Ecology. Human Anatomy.

EXPERIENCE WITH AN INTENSIVE PRACTICE-ORIENTED SCIENCE
PROGRAM FOR COLLEGE-BOUND HIGH SCHOOL JUNIORS & SENIORS.
James B. Patrick, Mary Baldwin College, Staunton, Va.
24401

Since 1977 Mary Baldwin College has operated a special
summer science program for college-bound high school
juniors and seniors ($S_3P!$). The format of $S_3!$ is intended
to utilize the experience that Mary Baldwin faculty have
gained in the presentation of high-intensity "total im-
mersion" instruction during the years that the Governor's
School for the Gifted has been taught at the college.
Some conclusions on the effectiveness of this type of
instruction with students who are not specifically desig-
nated as "gifted" will be presented. A second feature of
$S_3P!$ is its stress on concrete, tangible skills as an
essential feature of realistic science instruction; a
corollary of that feature is close student-teacher contact
and use of a realistic environment - well equipped labor-
atories and modern instrumentation which the student act-
ually uses. A third feature is an effort to prevent such
a program from becoming mere technician training by use
of a series of humanistic programs centered around the
Bronowski "Ascent of Man" film series. Some comments and
cautions about the use of this film series are offered.
Finally, some tentative conclusions will be offered about
the strengths and weaknesses of innovative programs like
$S_3!$.

GOVERNOR'S SCHOOL CHEMISTRY - 1978 VERSION. C. L.
Stanitski, Dept. of Chemistry, Randolph-Macon College,
Ashland, Va. 23005

The Governor's Program For The Gifted (GPFTG) selects
high-ability, rising seniors from Virginia's secondary
schools. This presentation describes the chemistry
program offered at the Mary Baldwin campus GPFTG center
during the Summer of 1978.

As an educator faced with the exciting prospect of
interacting with a group of academically select students,
a logical question which arises is - what should, can,
must, dare (choose the proper verb) I select for our discus-
sion/presentation? The rational for those topics included
in the final version will be described.

After a brief overview of stoichiometry and concentration
expressions, the broad area of chemical kinetics was stud-
ied, including its application to biological and nonbiolog-
ical systems. During the latter part of the program, molec-
ular structure and bonding were discussed. Lecture demon-
strations and student laboratory investigations in kinetics
and chemical structure were performed. Two of the lab.
investigations will be described in detail.

MATHEMATICS EDUCATION IN AUSTRALIA. H. W. Straley.
Mathematics Dept., Woodberry Forest Sch., Woodberry Forest,
Va. 22989, and Newington Col., Stanmore, NSW, 2048,
Australia

A teacher's perception of his own country's educational
system is illuminated by actually teaching in another coun-
try. This slide-discussion, comparing mathematics education
in Australia and the United States, is based on the author's
first-hand experiences as an exchange teacher in an Austra-
lian high school. The author visited and lectured in Aus-
tralian schools and universities, attended conferences, and
observed the grading of the Higher School Certificate Exami-
nations (College Entrance Examinations). This talk focuses
on "outback" one-teacher schools, elementary, secondary,
and college programs, texts, teacher training, and
competency examinations.

Engineering

Fifty-seventh Annual Meeting of the Virginia Academy of Science
May 8-11, 1979, University of Richmond

THE HIGH-SPEED CENTRIFUGE AS A MEANS FOR SEPARATING SUB-
MICRON PARTICLES FROM STACK GASES.   R. J. Babarsky* and
S. S. Fisher, School of Engineering and Applied Science,
University of Virginia, Charlottesville, Va. 22901.
    The use of a high-speed, high-throughput centrifuge for
separating submicron fly-ash particles from stack gases
exhausted by coal-fired power plants is considered.   The
design of such a centrifuge is reviewed, important consid-
erations in its design are discussed, and its potential
performance relative to other devices used for this purpose
is considered.   Apparatus for some planned proof-of-
principle tests is also described.

HAMPTON ROADS 208 PLAN. Paul E. Fisher,* Hampton
Roads Water Quality Agency.
    The HRWQA, a consortium of the SVPDC, PPDC and
HRSD, was established in 1974 to be the designated
208 planning agency for the Southeastern and
Peninsula area of Virginia.   The Agency applied
for and received a $2.5 million EPA grant to
develop a water quality management plan for an
area encompassing fourteen cities and counties and
ten major rivers and estuaries.   The planning pro-
cess included the identification of treatment
facility needs over a twenty year period for muni-
cipal and industrial sources, construction priori-
ties for wastewater treatment works, development
of a process to identify and control non-point
sources of water pollution, and the development of
an institutional/management program for carrying
out the plan elements.   In developing the plan
components, the Agency attempted to build on the
prior wastewater treatment planning done by HRSD
and the other municipal treatment agencies and
focused on significant gaps in the water quality
data base. The principal focus of the work, there-
fore, was in the area of water quality sampling
and modeling for the major water bodies, and non-
point source sampling and modeling.   The plan was
completed in late summer 1978, and public hearings
were held in October of 1978.

A SOLUTION FOR THE OPTIMAL GAP OF A MONOPOLE ELEMENT MOVING
IN A SINUSOIDALLY DISTRIBUTED MAGNETIC FIELD.   William P.
Harrison, Jr., Div. of Eng'rg. Fundamentals, Va. Polytechnic
Inst. & State Univ., Blacksburg, Va. 24061
    Couloumb's Law is used to establish the x- and y-compo-
nent forces acting on a monopole of strength M in an x-y
planar space under the influence of one other monopole, of
strength M', located on the x-axis. M' is then replaced by
a distributed field along the x-axis having the form $M' =$
$M'_{max} \cos(\pi x / x_p)$, where x_p is the half period (over 180°) of
this waveform. Integration over the full x-axis (from $-\infty$ to
$+\infty$) yields the total-force components, F_x and F_y, acting at
M. Restricting motion of M to x-direction translation only,
maximizing the acceleration equation reveals that a vertical
air gap of about $0.2x_p$ is the optimum placement for monopole
M above the x-axis and will result in maximum x-direction
acceleration.

AN ENGINEERING/ECONOMETRIC MODEL OF THE U.S. ALUMINUM
INDUSTRY. W. R. Hibbard, Jr., A. L. Soyster*, and M. A.
Kelly*, Virginia Polytechnic Institute and State University,
Blacksburg, Va. 24061
    A large scale, time dynamic linear programming model
simulating the U.S. aluminum industry has been developed us-
ing an engineering representation of the flow of materials
from mining through refining, smelting and fabrication with
special emphasis on scrap recycling. The aluminum supply
model is driven by a set of econometric demands derived from
historical data. The model results projecting industry in-
vestments and operations from 1977 until 1994 are reported
and discussed, particularly as they relate to Mineral Policy.

ION TIME-OF-FLIGHT MEASUREMENTS IN UF_6 FLOWS BY THE LASER-INDUCED-BREAKDOWN METHOD. M. C. Hodgins* and S. S. Fisher, School of Engineering and Applied Science, University of Virginia, Charlottesville, Va. 22901.

A method has been developed by which velocities in UF_6 flows are measured by focusing a high-power, pulsed nitrogen laser within the flow and causing electrical breakdown. Ions are formed in this process, and these ions are then collected by a probe located at a known station downstream. The time delay of the probe signal relative to the laser pulse allows one to deduce the flow speed. This method has been applied to high speed free-jet expansions of UF_6 formed by flowing UF_6 through a small nozzle into a vacuum chamber. For these jets, the high UF_6 flow rate is handled by condensing the jets directly on a liquid-nitrogen-cooled plate. These velocity measurements are interpreted in terms of the relevant fluid mechanics and are compared to similar measurements obtained by other methods.

SOLAR ABSORPTION REFRIGERATION FOR THE CONTROL OF INSECTS IN STORED AGRICULTURAL PRODUCTS. F. A. Iachetta, J. T. Beard, C. C. Alling*, and H. J. Manning*. Dept. of Mech. and Aero. Engrg., Univ. of Va., Charlottesville, Va. 22901, and D. P. Childs* and L. W. Fletcher*. ARS-USDA, Richmond, Va. 23240

This paper presents the results of a study of a proposed new method for insect control in post-harvest stored agricultural products. The method is based on the fact that the larvae of the cigarette beetle are killed and the growth cycle is interrupted if the commodity is maintained at or below 40°F for more than 21 days.

The proposed system would use an annual-cycle solar-driven aqua-ammonia absorption refrigeration system to produce ice for cooling of tobacco storage facilities.

Ice forms on tubes, is produced throughout the year, and is used approximately one month a year to provide environmental cooling of the tobacco storage for insect control.

This system offers several advantages over one in which the cooling is produced as needed. The solar collectors and absorption refrigerator can be many times smaller as they are used throughout the year. The storage tank provides a buffer between the variable energy source and the cooling load; the cooling capacity is developed when it is sunny, but the tobacco storage can be cooled at a time when the weather is cold and the cooling load is at a minimum.

Results of a computer simulation written to aid in the design of the system and the analysis of system parameters will be presented.

THE ALARMING PERCENTAGE OF U.S. PATENTS GRANTED TO FOREIGN NATIONALS vs. THE AMERICAN ENGINEER. Howard R. Johnson

Having worked in research for a number of years it was a shock to learn that in many of the 20 top technical categories of U.S. patents that American citizens trailed painfully. The office of Technology Assessment & Forecast gave an early warning report to the Dept. of Commerce in 1973 showing that the following prevailed and that "very shortly" the following would be true:

	1973	"very shortly"
Purification of molten iron	77%	??
Automotive fule devices	61%	??
Super conductors	72%	90+%
Liquid fuel rockets	31%	65%
Automatic arc-welding	41%	78%

We are now past the "very shortly" time period and the percentages continue to slide. It cannot be forecast just when the last American citizen will file a technical patent, but it can't make much difference when the percentages are as low as they are. Add to this the attitude of the Justice Department where the 9th District Court has never upheld a patent, or the west coast where no patent has been held valid for 20 years, and you have the picture of a foregone reality.

WATER QUALITY TRENDS IN THE NANSEMOND RIVER. Linda R. Kilch. Dept. of Estuarine Processes, Va. Inst. Mar. Sci., Gloucester Point, Va. 23062.

The Nansemond River, a tributary of the James River, has exhibited severe water quality conditions in the past. High fecal coliform levels, low dissolved oxygen concentrations, and excessive nutrient levels have been observed by various researchers in the past thirteen years, especially in the headwater region of the estuary. An overloaded sewage treatment plant and non-point source runoff, coupled with poor flushing in the headwater region of the river has been suggested as the source of water quality problems.

A COMPUTERIZED ENERGY EVALUATION OF SCHOOLS UTILIZING PSECS4 A.C. Pritchard*, R.R. Somers, II*, and L.S. Fletcher. Center for Energy Analysis, Dept. of Mech. and Aero. Engr., Univ. of Va., Charlottesville, Va. 22901

As energy prices continue to rise, many school systems have initiated energy conservation programs in an effort to save money by reducing energy consumption. However, these school systems often require assistance in determining what energy conservation measures are cost effective and in what order the energy saving techniques should be implemented. The Public Schools Energy Conservation Service – Version 4 (PSECS4) computer software package recently has been released by the U.S. Department of Energy (DOE) to help supply the energy management assistance needed by many school systems. The PSECS4 computer program provides recommendations both for changes in the operation of school facilities as well as for capital improvements to the school building envelope and energy systems to reduce energy consumption. PSECS4 also computes the energy and fiscal savings resulting from effective energy conservation measures.

The Center for Energy Analysis at the University of Virginia recently has completed a study of seven Albemarle County school buildings using the PSECS4 software. Results of this study will be used to demonstrate the capability of PSECS4 to point out energy-consuming inefficiencies in school buildings and to approximate the cost of implementing energy conservation techniques.

ENERGY CONSERVATION METHODS FOR PUBLIC SCHOOLS. R.R. Somers, II*, B.C. Chandler*, and L.S. Fletcher. Center for Energy Analysis, Dept. of Mech. and Aero. Engr., Univ. of Va., Charlottesville, Va. 22901

Increasing fuel costs have compelled many school systems to reexamine their energy-consuming practices as they seek to minimize energy expenditures through reductions in fuel use. It has been estimated that over $600,000,000 could be saved in school buildings through proper energy management requiring virtually no capital investment. The Center for Energy Analysis at the University of Virginia recently has had the opportunity to conduct energy audits in a number of elementary and secondary schools in central Virginia. During the course of these studies, a number of energy-wasting problems have been observed that are common to a majority of the school facilities that were inspected. Undoubtedly, many of these smae problems exist in shcool buildings throughout the Commonwealth of Virginia. Energy conservation measures that can be used to correct these inefficient uses of energy in schools will be reviewed. Results of computerized studies of the energy use of several schools will be used to indicate the relative magnitudes of the savings that could be realized through efficient energy consumption.

VIRGINIA'S NONPOINT SOURCE CONTROL STRATEGY. E. R. Southerland*, Virginia State Water Control Board, Richmond, Virginia 23230

Section 208 of the 1972 Federal Water Pollution Control Act Amendments requires each state to develop a nonpoint source control strategy. The keystone of the State Water Control Board (SWCB) strategy for Virginia is the development of Handbooks which describe Best Management Practices (BMPs) for reducing or preventing pollution from agriculture, forestry, mining, urban areas, hydrologic modifications, saltwater intrusion, and residual waste disposal. Each BMP Handbook was developed by a Technical Advisory Committee of State and Federal agencies and a Citizens Advisory Committee of special interest groups who have expertise in the land use. All BMPs are considered open to revision as better understanding of nonpoint source controls is gained through field implementation and monitoring of their effectiveness. Because of the lack of data on BMP benefit-costs, the SWCB strongly supports a non-regulatory program for BMP implementation. The voluntary strategy will be outlined in a Management Handbook to be prepared in 1979 by the SWCB and its State Policy Advisory Committee. An assessment will be made statewide to identify nonpoint source problem areas. Public education programs and technical and financial assistance for BMP implementation will be concentrated in the top priority watersheds.

NONPOINT SOURCE STUDIES IN THE OCCOQUAN BASIN. B. L. Weand and T. J. Grizzard*. Civil Engineering Dept., Va. Poly-technic Inst., Blacksburg, Va. 24061

The Occoquan Watershed, which lies on the southwestern periphery of the Washington, D.C. metropolitan area, has an important water supply reservoir at its mouth and a rapidly expanding urban area at an intermediate point up-stream. This impoundment, which serves an estimated 600,000 people, has exhibited a rapid decline in water quality during recent years. The severity of this problem prompted the Virginia State Water Control Board to promul-gate regulations requiring the consolidation of existing wastewater discharges in the basin and subsequent treatment by a state-of-the-art advanced waste treatment process.

Recent studies, however, have shown nonpoint pollution to be a problem of increasing importance as point source waste discharges are treated to a higher degree or eliminated completely. The Occoquan Watershed Monitoring Laboratory, located in Manassas, Virginia has been in-timately involved in research aimed at defining the impact of nonpoint pollution in the Occoquan Basin. The scope of these studies, as well as research currently underway will be discussed.

AN ENGINEER'S DESIGN: PUBLIC PARTICIPATION AND THE PRESS. J.C. Webb and G.R. Webb. Dept. of Physics, Christopher Newport College, Newport News, VA 23606

Despite herculean efforts, engineering firms are fre-quently unsuccessful in involving citizens in the planning and design stages of large-scale public works and regula-tions. Citizen input invariably arises after plans have been drawn and preliminary construction has started. Such a situation is undesirable for the citizens, who perceive themselves the victims of an unknown agent, and for the engineer, who is, after all, committed to the public good.

Reliance on the techniques of public relations to ensure the needed participation is the standard practice of these firms. This practice is not adequate. We assert that engineers need to return to those techniques in which they are well-schooled, the analysis of systems, in their design of an approach to public participation.

We present the results of an experiment to increase citizens' awareness of the effect that a water quality study might have on their area, and in turn draw lessons on an alternate mode for reaching the public. The study con-sidered is the 208 waste treatment management plan for Tide-water; citizens are residents of the rural James River county of Isle of Wight. The vehicle for the experiment was the weekly paper for the area, the Smithfield Times. (Aided by NSF Grant #OSS77-23962)

Environmental Science

Fifty-seventh Annual Meeting of the Virginia Academy of Science
May 8-11, 1979, University of Richmond

A DETERMINATION OF THE CONCENTRATION OF AROMATIC HYDROCAR-BONS IN THE WATER AND ZOOPLANKTON OF THE ELIZABETH RIVER, NORFOLK, VIRGINIA. C. W. Banks. Dept. of Biology, Old Dominion Univ., Norfolk, Va. 23508

The levels of aromatic hydrocarbons in the water and zooplankton of the Elizabeth River were determined by gas chromatography. Samples of the water from three sites were filtered and extracted using carbon disulfide. Samples of the zooplankton from the three sites were sieved, digested in methanol-KOH in an incubator-shaker, and extracted into carbon disulfide. The extracts were injected into a Varian Aerograph model 1400 gas chromatograph. A disc integrator was used to measure the relative areas under the curves. Standard curves and retention times were used to quantify and identify the compounds. Four compounds, benzene, toluene, xylene, and naphthalene, were identified, with a concentration range of four to 280 ppb for the water, and 50 to 1,180 ppb for the zooplankton.

There was a significant (α= .05) correlation of concentrations with site location and depth, and a significant regression of the levels in the zooplankton on the levels in the water. Each compound is accumulated at a different rate in the zooplankton, depending on the aromatic hydrocarbon concentrations in the water and probably on the concentrations in the phytoplankton.

A COMPARISON OF AIR QUALITY MEASUREMENTS FOR THE 1977 AND 1978 REGIONAL OZONE STUDY*, G.E. Copeland, Ed Barry and Nehl Aldridge, Dept. of Geophysical Sciences, Old Dominion University, Norfolk, Va. 23508.

Regional ozone monitoring experiments were conducted in Eastern Virginia in the summers (1977 & 1978) by ODU, VSACB and NASA. 1978 results at urban and rural sites are presented. Analysis of 1200 hours of data indicates values of NO_x well below the ambient air standards and indicate a source of NO to the NNW of ODU. Total hydrocarbons (THC), methane (CH_4), non-methane hydrocarbon (NMH) and ozone (O_3) were monitored at ODU and Deep Creek Va. THC at Deep Creek averaged 2.5 to 4.0 ppm from N to WNW while at ODU their range was 2.8 to 4.6 with azimuth N and NNW. CH_4 at Deep Creek ranged from 2 to 4 ppm, at ODU CH_4 ranged from 0.2 to 0.4 ppm. NMH at Deep Creek ranged from 0.4 to 0.7 ppm above the standard of 0.24 ppm. At ODU NMH ranged from 1.7 to 3.8 ppm.

Ozone averages at the rural site showed a range of 2S ppb @ ENE (106 hrs) to 70 ppb @ NW (19 hrs). At the urban site the O_3 values ranged from 18 ppb @ WNW (90 hrs) to 36 ppb @ SE (81 hrs). O_3 values during 1978 never exceeded the 120 ppbv standard at these sites. O_3 exceeded 80 ppb at Deep Creek 10% and at ODU S.S% of the time. Evidence indicates transport of high concentrations of O_3 to Tidewater by N, NW and SW winds. These results agree with those found in the 1977 O_3 study.[1]

*Partially funded by NASA-LRC [NAS1-14193-S9].
[1]Virginia Academy of Science, S6th Meeting, 1978.

PASSIVE SOLAR ENERGY: FRUGAL BUILDING FOR VIRGINIA'S CLIMATES. C.James Bier Dept. of Chemistry Ferrum College Ferrum, virginia 24088

Passive solar energy means the use of design in arranging building materials, components,surfaces, and spaces to allow the building to best utilize the seasonal and daily path of the sun to provide comfortable interior conditions year round by natural flows of energy. This paper will discuss generic passive solar design concepts with their features and their problems. The paper will also present the author's design innovation Vertical Solar Louvers as they are used in his own home and suggested design applications for Virginia's various climates. Vertical Solar Louvers are a set of massive rectangular columns which are oriented 45° immediately behind south-facing glass. They act as automatic thermal control-storage elements by allowing full penetration of the winter morning sun into the building interior while capturing and storing afternoon solar radiation for night-time use and to prevent overheating of the living space.

AN INVESTIGATION INTO THE RELATIVE IMPACTS OF VARIOUS ENVIRONMENTAL FACTORS ON BREATHING DIFFICULTY AND EYE IRRITATION AMONG SENSITIVE PEOPLE IN TIDEWATER VIRGINIA - 1978 Joseph W. Crawford, Jr.*, Hampton Roads Region, State Air Pollution Control Board, Pembroke IV - Suite 409, Virginia Beach, Va. 23462.

This investigation is an attempt to make an assessment, based on purely statistical analyses, of the relative importance of the five Environmental Factors of temperature, humidity, pollen count, fungus count, and photochemical oxidants (ozone) in breathing difficulties and eye irritation experienced by a group of known sensitive people. The investigation was conducted during the months of June through October 1978.

ESTIMATING RELATIVE POTENCY FROM THE HYPERBOLIC DOSE-RESPONSE MODEL.
J. T. Crowe, Jr., A. H. Robins Co., Richmond, VA 23220.

The fundamental dose-response function for many pharmacological and toxic agents can be derived from the assumptions of Receptor Theory and the Law of Mass Action. This function is the rectangular hyperbola, $y = Y_m d/(K+d)$, where y is the response, Y_m the maximum response, d the dose and K is equivalent to the median effective dose (ED50). If two drugs have the same maximum response, an estimator, $R = K_S/K_T$, can be derived which expresses the relative potency of a test drug, T, to a standard, S. This paper presents the derivation and properties of the estimator, R.

THE INPUT OF LEAD AND OTHER METALS TO ECOSYSTEMS BY DRY DEPOSITION. Robert W. Elias, Biology Department, VPI & SU, Blacksburg, VA 24061.

Before 1970, mass balance estimates of ecosystem inputs and outputs generally overlooked inputs by the dry deposition of atmospheric aerosols. Early determinations of dry deposition were made by measuring wet only and wet plus dry deposition in the same type of collector. These measurements, and other similar efforts, are not compatible with the aerodynamic mechanisms of the deposition of aerosols. Recent studies of deposition rates for lead in roadside and remote ecosystems show that these rates are a function of particle size and concentration, plus windspeed and foliar orientation. In this report, natural removal mechanisms, such as rain, were observed by field and SEM measurements, while artificial removal mechanisms (acid-washing) were evaluated as efficient methods of measuring surface deposition on leaves.

The results of these studies show that: 1) artificial collector plates generally overestimate rates of dry deposition by about 25%; 2) laboratory cleaning methods can efficiently remove particles from pine needle surfaces without disturbing interior tissues; 3) lead inputs by dry deposition may represent 40-60% of the total atmospheric input into an ecosystem; and 4) the input of other metals, such as Ca, Sr, Ba, K and Rb, may be as much as 10% of the total atmospheric input.

PHOTON CORRELATION IN LASER DOPPLER SPECTROSCOPY FOR THE DETERMINATION OF PARTICLE SIZE. Aleyamma George*. Dept. of Physics, Norfolk State College, Norfolk, Va. 23504

As the particle moves within the region illuminated by a continuous laser beam, the frequency of the light scattered will be shifted by a very small fraction due to the Doppler effect. The measurement of the shape of this spectrum of frequency shifts is achieved by digital autocorrelation. The photocurrent of the photomultiplier tube (PMT) will give rise to a fluctuation spectrum characterized by the autocorrelation function of the detector output signal. The half width for this spectrum is expressed as $HW = 16D\overline{q}$ $Sin^2\theta/2$ where θ refers to the scattered angle. Thus the particle diffusion coefficient D, and by using the Stokes-Einstein relationships with appropriate slip correction, the particle size can be determined.

In the experiment, the output from the PMT is fed on to a Digital autocorrelator and the analysed data relayed to a minicomputer and processed in real time. This new technique affords precise and rapid measurement of macromolecular diffusion coefficients and particle sizes in hydrosols or aerosols. (Aided by E.P.A. Grant R803765).

WATER QUALITY IN THE HAGUE, NORFOLK, VA., EVIDENCE OF CHANGE. R.E. Johnson. Inst. of Oceanography, Old Dominion Univ., Norfolk, VA. 23508

The Hague is a semicircular tidal basin 2,100 feet in diameter connected at the midpoint of its circumference to the Elizabeth River. It is the bulkheaded remnant of two tidal streams. The Hague was dredged in 1974, deepening the main portion by over four feet. The water quality study performed in summer of 1973, prior to dredging, indicated fecal coliform bacteria counts in excess of 4,500 MPN/100ml average in the Hague. The present study, summer of 1978, indicated MPN counts in excess of 100,000 per 100ml. In addition, both arms of the Hague are now about equal in coliform count. Previously, the Colley Creek arm (westarm) was well below 2,500 MPN/100ml. Tidal surveys indicated that coliform counts were higher at low tide than at high tide and were substantially lower in the Elizabeth River adjacent to the Hague. This implies that the source of the coliform bacteria is within the Hague drainage system.

THE MAX VARIANCE RATIO IN EXPLORATORY DATA ANALYSIS. D. V. MATHUSZ, Ops Res Div of LOGC Ft. Lee, VA. 23801

Exploratory Data Analysis is essentially investigative in nature and as such, its procedures involve graphic displays of the structure of data. Selection of these graphic devices and the data sets are then primary questions for the researcher. To aid in these decisions, a simple index has been devised to measure the amount of clustering at the range extremes or its opposite, i.e. a central cluster whose range is defined by "outliers." This index is the MAX Variance Ratio (MVR). It is the ratio of the variance of the data divided by the maximum variance possible for the same number of data points "n", free to take any values over the same range "R". This MVR has a scale of zero to unity. This unit scale can be divided by a Neutral Variance Ratio (NVR), that defines when the aggregate clustering at the range extremes reverts to the opposite effect. It is shown that the MAX Variance for even n is a f(R) but that for odd n is f(R,n) which asymtotically converges toward f(R) as n increases. It is also shown that in the limit NVR is 1/3 of f(R). Tables and graphs are provided for small n, not close to the limiting values. The index is demonstrated in a classic example.

SEWAGE EFFECTS IN A SMALL STREAM. R. A. Matthews*, M. Flora*, C. Caupp*, and M. Boucherle*. Ctr. for Environmental Studies, Dept. of Biology, Va. Polytechnic Inst., Blacksburg, Va. 24061.

During the winter and early spring of 1978 a study was conducted to evaluate the impact of sewage effluent upon a small stream in southern Indiana. We found the stream to be moderately impacted, sewage effluent representing close to ten percent of the total discharge downstream from the treatment plant outfall. Turbidity, conductivity, ammonia, and soluble reactive phosphorus concentrations increased below the outfall. Dissolved oxygen concentrations demonstrated a typical oxygen sag with recovery. Fish, benthic, and algal diversities were significantly reduced at the site of effluent input; however, both fish and invertebrates recovered downstream.

IMPACT OF IMPOUNDMENT ON DOWNSTREAM FISH AND BENTHIC MACROINVERTEBRATE COMMUNITIES IN A PIEDMONT STREAM. M. Mauney and J. J. Ney. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

Impact of a shallow, non-stratifying impoundment on stream biota was assessed through a one-year comparison of upstream and downstream stations. Stream physico-chemical properties were not altered.

Estimated density, biomass, and production of the ben-thic community were greater in the tailwater than at the upstream or most downstream station and occurred primarily through increase in non-insect groups. Changes in macroinvertebrate composition appeared to be related to differences in food availability. The taxonomic composi-tion of the fish community was similar among stations, but fish biomass was substantially greater in the tailwaters than at the other locations. The fish community in the tailwaters was not stable. Increased fish biomass and instability in the tailwaters may result from upstream movement and reservoir emigration. Transience may be enhanced by competition for food and/or space during some seasons.

The downstream impact of the reservoir was very localized. Benthic and fish communities examined 1200 m below the im-poundment were equivalent to upstream levels or were intermediate between those of the upstream and tailwater station.

AN INTERACTIVE COMPUTER SIMULATION OF A 3-COLOR LIDAR SYS-TEM. J. I. Mukula, Department of Geophysical Sciences and G. E. Copeland, Department of Physics, Old Dominion Univer-sity, Norfolk, VA 23508.

A 3-color raman range-resolved lidar computer stimulation is performed via an airborne platform traversing a fossil fuel power plant. The program's design allows the imput of atmospheric buoyant forces and plant dynamic conditions to realistically approach the actual conditions which are per-tinent to the system response.

The range resolved backscattered signals involve the fundamental infrared (1.06E-6nm), the second harmonic or green portion (.5320E-6nm), and the raman shifted (.6073E-6nm) wavelength. Subsequent returns at the detector con-sist of photons and current with a Maxwellian noise added.

Profiles of the data indicate the scattering ration at specified elevations, and ideally, a distribution of the specific particulate in a plume or possible a localized air-shed.

NITRIC OXIDE AND THE "SUNDAY EFFECT" IN URBAN ST. LOUIS. E. J. Prior and J. R. Schiess. NASA Langley Research Center Hampton, VA 23665

Recent analyses of pollutant measurements within large urban plumes have suggested that ozone levels are often greater during Sunday than during the weekdays when traffic emissions are most concentrated. Correct interpretation of this trend, which has been called the "Sunday Effect," is of major importance for the development of pollution con-trol strategies since the trend implies that limitations on auto emissions may not necessarily result in lowered local ozone levels. To investigate this question, we have ana-lyzed high quality 1976 pollutant measurements from the St. Louis Regional Air Pollution Study (RAPS) conducted by the Environmental Protection Agency. We examined Sunday and weekday averages and also compared the upwind, central urban, and downwind variations of the ozone levels. An empirical model has been constructed to describe the var-iability of the daily St. Louis maximum ozone levels for each day in 1976. The model shows that decreasing ozone levels in the urban St. Louis area are related to increas-ing nitric oxide emissions. The greater weekday nitric oxide levels result in a larger depletion of ozone during weekdays than on Sundays. These results represent statistical confirmation of the urban nitric oxide scaven-ging hypothesis that has been put forward recently based on smog chamber studies and theoretical modeling.

1978 SOUTHEASTERN VIRGINIA URBAN PLUME STUDY: FIELD MEAS-UREMENTS. D. S. McDougal,[*] G. L. Gregory,[*] and H. S. Wagner,[*] Langley Research Center, NASA, Hampton, Va. 23665,

The Southeastern Virginia Urban Plume Study (SEV-UPS) is a multiyear program to evaluate the performance of unproven NASA remote sensors designed to measure urban air pollution from surface and airborne platforms. As part of the July 10-28, 1978, SEV-UPS activity, several experiments were per-formed to measure the photochemically produced ozone and its associated primary precursors upwind, within, and downwind of the Hampton Roads, Virginia urban complex. Air quality (O_3, NO, NO_x, CH_4, THC, CO, and N_2O) and meteorology (wind vector, temperature, dewpoint, solar insolation, and mixing layer height) parameters were measured from a variety of air-craft, surface, and balloon platforms.

On July 24, the daytime variation of photochemically pro-duced ozone in an urban area (20 km by 20 km box centered in the source area) was found to vary from 45 ppb (0600 e.d.t.) to a maximum of 105 ppb (1500 e.d.t.). The rise is attribu-ted to O_3 re-entering the urban box due to a sea-breeze wind shift. On July 27, the downwind aging, transformation, and transport of pollutants from an urban plume were measured. Although the day was characterized by broken clouds and mod-erate temperatures, the airborne O_3 increased from an upwind value of 60 ppb to a downwind (4-6 hours aging) level of 100 ppb. For contrast, a similar experiment performed August 4, 1977, during clear skies and high temperatures, showed down-wind O_3 levels to be as high as 150 ppb.

TROPHIC RELATIONS AMONG YOUNG-OF-YEAR SPORT FISH SPECIES IN THE LITTORAL ZONE OF VIRGINIA RESERVOIRS. J. J. Ney, E. D. Ricci,[*] and W. R. Reynolds.[*] Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

Food habits of coexisting young-of-year fishes were examined from summer cove rotenone catches in Claytor and Smith Mountain Lakes. In the former, diets of three ende-mic species, largemouth bass, crappie and smallmouth bass, were compared to the food habits of the exotic, white bass. Diets of the three native species demonstrated partial resource partitioning, but white bass food habits were congruent with crappie, indicating possible trophic compe-tition. In Smith Mt. Lake, diets of native largemouth bass and stocked striped bass were analyzed. Food habits by major category did not differ significantly between the species, although striped bass fed more heavily on fish while largemouth bass utilized a high proportion of neu-stonic insects.

In both situations, dietary overlap between young-of-year native and exotic sport species indicates the possibility of trophic competition which may affect growth and survival. Predictions of impact of exotic introductions should include detailed analysis of this overlooked aspect of interspecific relations.

AN EMISSIONS INVENTORY SUITABLE FOR MODEL STUDIES OF AIR QUALITY IN SOUTHEASTERN VIRGINIA. E. E. Remsberg, G. E. Woodbury[*], and L. C. Quinn[*] NASA Langley Research Ctr, Hampton, VA 23665 and D. A. Brewer, Joint Institute for Adv-ancement of Flight Sciences, Geo. Wash. Univ., NASA Langley Res. Ctr., Hampton, VA 23665.

One of the largest uncertainties in air quality modeling is in the specification of the source function due to area and point source emissions. Up to now, the area species em-issions were available on an annual basis for each city or county in Virginia Region VI. The area compilation from vehicle traffic and other sources that is presented here has been distributed over 1 km^2 grids. The point source data can be superimposed on these grids by using a multiple point source model that includes plume rise information. Consis-tency checks have been made on the data to assure that the inventory is reasonable. The inventory has been computerized so that it can be more easily updated in the future. These source function data are being applied to a box model cal-culation of air quality during the summer of 1978, and the results are to be compared with field measurements of ozone and its precursors over that same time period.

A STUDY OF LINEAR STATISTICAL CORRELATIONS BETWEEN   ATMOS-
PHERIC OZONE CONCENTRATIONS AND ABSOLUTE HUMIDITY IN
NORFOLK, VIRGINIA, 1977. T. L. Rettig*, G. E. Copeland,
Dept. of Physics, Old Dominion University, Norfolk,
Virginia 23508
   Barometric pressure, atmospheric ozone concentrations,
temperature and relative humidity readings were measured
at ODU Norfolk, VA and the Norfolk International Airport
during the summer of 1977. These data were processed to
find linear correlations. A -0.052517 correlation coef-
ficient was found to exist between ambient ozone concen-
trations (ppB) and absolute humidity (g/m^3) using all data.
A correlation of -0.062783 for night time conditions and
of -0.048315 for daily time was obtained from the same
data. A correlation of 0.631192 was found to exist between
ozone concentrations and temperature (celsius) using all
data. A correlation of -0.153991 was found between ozone
and pressure (TORR) and a -0.669587 correlation between
ozone and relative humidity (%) using all data.
   In conclusion, no significant correlations exist between
ambient ozone and water content of the atmosphere.

MUNICIPAL LANDFILL LEACHATE IN THE GROUND AND
SURFACE WATER, CHESAPEAKE, VIRGINIA: I. HEAVY
METALS. J.H. Rule. Dept. of Geophysical Sciences,
Old Dominion University, Norfolk, Virginia 23508.
   The City of Chesapeake, Virginia, has been using
pH and Cl$^-$ as routine monitoring parameters for
leachate detection at its municipal landfill. Water
from two landfill monitoring wells, two private
wells near the landfill, and four surface water
stations were analyzed. The pH, solids, and Cl$^-$
levels at one monitoring well indicate that it is
being influenced by nearby saline canal water.
There was no evidence that landfill leachate was
reaching the second well. The presence of an im-
pervious clay layer suggests that the present
monitoring wells may be too deep to detect any lea-
chate movement. Levels of Zn, Cu, and Cd in the
monitoring wells probably originated from dissolu-
tion of the galvanized well pipe. No significant
levels of Cd, Cr, Cu, Ni, Pb, or Zn were found in
the surface waters or two private wells near the
landfill. It is concluded that Cl$^-$ is not a desir-
able parameter for monitoring landfill movement,
especially near the saline surface waters. Near
surface stratigraphy, the groundwater table, and
surface drainage indicate the potential for lea-
chate movement from the landfill area toward
adjacent waterways. ODURF Summer (1979) Grant #GR-12.

SIMULATION OF INDUCED FLUORESCENCE OF PHYTOPLANKTON IN THE
MARINE ENVIRONMENT. W.L. Staton*, J.W. Campbell, NASA
Langley Research Center, Hampton, VA 23665
   In recent years, NASA Langley has been engaged in remote
sensing of the marine environment using lasers. The LIDAR
(Light Detection and Ranging) technique has been successful-
ly applied to determining in vivo fluorescence of chloro-
phyll a, both in the laboratory and the field. Chlorophyll
a is the essential photosynthetic pigment found in all plant
life and is important to the entire food chain. Chlorophyll
a measurement techniques previously available to marine
scientists include only those that require water samples
from the body of water under examination. To alleviate the
necessity of water sample collection and the resultant res-
trictions on coverage of surface sampling, a multispectral
remote fluorosensor system has been under development to map
chlorophyll a contained in algae from a helicopter or low-
flying airplane.
   To study the accuracy of this system, we are developing a
computer model that simulates the fluorescence energy return-
ed by algae when it is excited by light of various wave-
lengths. The model makes use of a multilayered water column
in which chlorophyll a and light attenuation are varied with
depth. Simulated fluorescence data are fed into the algo-
rithm which estimates the chlorophyll a concentration assum-
ing a uniform chlorophyll concentration with depth, and
uniform attenuation with depth. Resulting estimates of
chlorophyll are then compared with the true concentration.

REMOTE SENSING OF THERMAL PLUME DYNAMICS NEAR THE SURRY
NUCLEAR POWER STATION ON THE JAMES RIVER. T. A. Talay,*
NASA-Langley Research Center, Hampton, Va   23665
   Remote sensing of thermal discharges entering receiving
waters offers the advantages of determining synoptic and
temporal distributions without the requirements of exten-
sive in situ surveys. The discharge dynamics may be related
to specific riverflow, tidal, and bathymetric conditions.
   On May 17, 1977, the NASA Langley Research Center con-
ducted a remote sensing experiment over the James River,
whereby thermal scanner data for the thermal plume near the
Surry nuclear power station were obtained for six overpasses
by the experiment aircraft. These data provided discrimina-
tion of flow patterns over most of one tidal cycle.
   The resultant thermal mappings show the direct response
of the thermal plume to the combined riverflow and tidal
currents, and the channeling effects of the surrounding
bathymetry. For the day of the experiment, excess temper-
atures for the plume above ambient river waters did not
exceed 2°C except for small areas around the discharge.
The thermal mappings also demonstrate the nonhomogeneous
ambient temperature structure in the river caused by
sunlight heating effects during the course of the day.

A SUMMARY OF THE METEROLOGICAL CONDITIONS AND THE VERTICAL
CARBON MONOXIDE PROFILE IN THE ST. PETERSBURG, FLORIDA
AREA: 14-17 AUGUST, 1978. David A. Topping, Jr.*,
Dept. of Physics, Old Dominion Univ., Norfolk, VA 23508
   During 14-17 August 1978, several tests of The MAPS
(Measurement of Air Pollution from Satellites) remote
sensor were made from an aircraft over the St. Petersburg,
Fla. area. The aircraft was equipped to measure outside
air temperature and dew point and to collect samples of
the outside air. Gas chromatographic analysis of the
samples for CO concentration, along with the temperature
data, allowed construction of vertical profiles of the
meterological conditions and corresponding CO concen-
trations. This report presents and discusses these
profiles.

Geology

Fifty-seventh Annual Meeting of the Virginia Academy of Science
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CADMIUM-ZINC RATIOS IN SPHALERITES FROM THE CENTRAL SHENAN-
DOAH VALLEY, VIRGINIA. Brian D. Baldwin* and W. C. Sher-
wood. Dept. of Geology, James Madison Univ., Harrisonburg,
Va., 22807
Sphalerite was mined as a zinc ore in past years at sev-
eral locations in the central Shenandoah Valley. As a re-
sult of similarity to zinc, cadmium occurs by isomorphous
substitution in almost all zinc ores. The purpose of this
study was to determine Cd/Zn ratios for a number of sphale-
rite samples. These ratios could then be compared to pub-
lished ratios and tested for trends based on geographic dis-
tribution or host rock type.
Samples were taken from 28 sphalerite showings located
in a linear trend along the strike of the dolomitic upper
Beekmantown formation. Solutions made in a mixture of nit-
ric and tartatic acids were dried, then redissolved and fil-
tered. The Cd/Zn ratio was determined by atomic absorption
spectrophotometry.
The results showed that the samples could be separated
into two categories based on type of host rock. Using
Cd/Zn x 1000, sphalerite from recrystallized dolomite showed
a mean of 22.3 and from the brecciated dolomite a mean of
7.9. These values were higher and lower respectively than
the published average for sphalerites occurring in the east-
ern U.S. Also discovered was a slight decrease in the ratio,
and a color change in the sphalerite, from the northern to
southern sample sites.

THE SEDIMENTOLOGICAL AND PALEONTOLOGICAL SIGNIFICANCE OF
CHAMA CONGREGATA FROM THE YORKTOWN FORMATION (EARLY
PLIOCENE) IN SOUTHEASTERN VIRGINIA. Felicia M. Boyd,
Dept. of Geology, College of William and Mary,
Williamsburg, Va. 23185
Chama congregata are found abundantly in coastal plain
sediments throughout southeastern Virginia. The Chama
beds reach a maximum thickness of 4.5 m. along the north
bank of the James River. The beds intertongue with sand
and silt to the east and south and are masked by other
shells or are truncated to the north and west. Chama are a
gregarious, inequivalvular, attached, marine bivalve.
Chamas occur as disseminated shells or in aggregates in
the Yorktown Formation. The organisms cement their shells
to a hard substrate or, in sandy environments, to other
shells. The encrusting chamas build prominent three-
dimensional structures which serve not only as massive
substrates for organisms, but are also traps and binders
for fine-grained muds and biofragmental sands. Chama
shells provide a substrate upon which gastropods, sponges,
annelids, bryozoa, barnacles, and byssally attached bi-
valves attach and find protection. Chama shells are com-
monly bored, and the weakened shells are reduced to sand -
sized particles by waves and currents. Examination of
Chama beds along the James River in Virginia, including
sediment analysis and a study of spatial relationships,
has revealed the importance of the organism as a particle,
a sediment trap and binder, and a substrate.

VARIATIONS IN GRAIN SIZE PARAMETERS AND BEACH PROFILES
DURING A TIDAL CYCLE AT FORT STORY, VA., Paul R. Bowen*
Albert W. Moore* Inst. of Oceanography, Old Dominion
Univ., Norfolk, Va. 23508
This study examines an unprotected beach environment
during a tidal cycle to observe changes in both grain size
distributions and small scale profile variations. The
coarsest sediments were found in the vicinity of the wave
plunge point. A secondary maximum of coarse sediments
located further onshore appeared to be the result of uprush
and backwash collisions. The beach profile showed cor-
relation between erosional areas and coarse mean grain size.
Accretional deposits located just seaward and landward of
the wave plunge point migrated with the waves during the
tidal cycle. Profile changes suggest that net erosion is
associated with the flood, resulting in maximum net erosion
at about high tide. Even more predominant net deposition
was observed during the ebb, with resultant net deposition
during the tidal cycle. Generally, sorting was progressively
better toward the dune line and skewness was predominantly
negative with some positive skewness in the vicinity of
the wave plunge point.

STRATIGRAPHY AND GEOMORPHOLOGY OF LATE PLEISTOCENE DEPOSITS
OF THE NORTHERN NECK BETWEEN THE CORROTOMAN RIVER AND THE
CHESAPEAKE BAY, VA. K.M. Farrell*, Va. Inst. of Marine
Science, Gloucester Point, Va. 23062.
Sediments and topographic features of the Northern Neck
provide evidence for a single transgressive-regressive epi-
sode in the late Pleistocene.
The dominant landforms in this area consist of 1) a north-
trending scarp (toe at 14 m) that parallels the Rappahannock
River, 2) an upland 18 to 28 m north of this scarp, 3) an
estuarine plain at 4 to 14 m south of this scarp, 4) a prom-
inent north-trending scarp (toe at 6 m) that truncates the
northwest-trending scarp, and 5) a plain (≤ 6 m) east of the
north-trending scarp.
The Pleistocene sequence in the vicinity of the White
Stone Bridge consists of a discontinuous peat bed (paludal)
overlain successively by a Rangia-bearing sandy mud (oligo-
haline fauna) and a muddy sand with abundant Crassostrea and
Mercenaria (mesohaline to euhaline fauna). A fine to
medium crossbedded sand which grades upward into fine sand
conformably overlies the muddy sand. The upper sand unit
coarsens seaward and pinches out upstream. East of the
north-trending scarp sandy mud predominates.
During Sangamon time when sea level was rising to a maxi-
mum of 14 m estuarine sediments were deposited in the ances-
tral Rappahannock River and in the ancestral Chesapeake Bay.
A split formed at the mouth of the ancestral Rappahannock.
As sea level fell a north-trending shoreline was cut at 6 m.

PRELIMINARY REPORTS ON THE SALTVILLE PLEISTOCENE BONE BEDS:
PREVIOUS EXCAVATIONS AND ARCHEOGEOLOGY. David Foster *,
Martha Evans *, and Charles S. Bartlett,Jr, Dept. of Geology,
Emory & Henry College, Emory, Virginia 24327.

A letter from Arthur Campbell to Thomas Jefferson in 1782
referred to large specimens of bones of Pleistocene mammals
at Saltville, VA. Thereafter, shafts dug for rock salt,
road and railroad cuts, drainage ditches, utility pole exca-
vations, and unauthorized diggings contributed to bone dis-
coveries. In 1917, Carnegie Museum salvaged a small collect-
ion of fossils from a cave-in at well number 69 and later in
1964, Olin Mathieson Chemical Corp. uncovered Pleistocene
bones while digging a drainage ditch in the western end of
the well-field. The Smithsonian Inst. and V.P.I. then con-
ducted systematic excavations near the pond area under the
supervision of Dr. Clayton Ray in 1966 and 1967. These and
previous excavations uncovered bones of Mammut americanum
(American Mammoth), Mammuthus primigenius (Wooly Mammoth),
Megalonyx dissimilis and M. jeffersonii (Sloth), Equus(Horse)
Rangifer tarandus (Caribou), Cervalces (Moose), Bison, Cervid
(Elk), and the following Musk Oxen: Symbos cavifrons, Booth-
erium sp, and Ovibovini sp.

Clovis points of the Paleo-Indians have been found in the
region. Our archeological findings included three pottery
groups from the Radford series and flint artifacts which were
found above and separate from the bone bed. However, one
Proboscidean tusk fragment was found in the bone layer ex-
hibiting carved features possibly manufactured by early man.

MINERALOGIC AND STRUCTURAL VARIATIONS IN THE LOVINGSTON
FORMATION DUE TO MYLONITIZATION. Steve K. Grimsley*, #44A
Northview Apartments, Blacksburg, Virginia 24060.

The Lovingston Formation in the northern part of the
Blue Ridge anticlinorium includes an older alkali feldspar
granite gneiss intruded by a coarse quartz monzonite pluton.
The area under consideration is a two-square mile section
along Rt. 635 west of Hume, Virginia. Changes in the
intensity of deformation at greenschist grade metamorphism
is responsible for a variety of textures, microstructures,
and mineralogies. Three narrow zones of intense mylonitiza-
tion have been identified and compared with the lesser
deformed rocks. Mafic mineral phases present in the rocks
tend to increase their susceptibility to intergranular
deformation and neomineralization. The dominant deforma-
tional phase of the quartz monzonite pluton in the area
studied is a mylonite or augen gneiss. Variations extend in
range from a mildly deformed meta-quartz monzonite to an
intensely strained ultramylonite. The alkali feldspar
gneiss consists of a slightly deformed rock with a linear
fabric defined by elongate mafic mineral aggregates. Within
the zones of intense deformation this older lineation is
overprinted by a mylonite or protomylonite foliation.

STRUCTURAL ANALYSIS OF THE QUANTICO SCHIST AND ADJACENT
UNITS NEAR LONG BRANCH RESERVOIR,VIRGINIA. Audrey Hrinda*
and Roddy V. Amenta, James Madison University, Harrisonburg,
Virginia 22801.

Mica schist, amphibolite, and granodiorite gneiss near
Long Branch Reservoir contain structural and textural fea-
tures that reveal a polyphase deformational history. Three
recognized s-surfaces and two lineation patterns relate to
two, possibly three, episodes of folding. The dominant
schistosity in the schist and amphibolite is parallel to
axial surfaces of upright, gently plunging folds. Micro-
scopic analysis reveals this schistosity to be a crenulation
cleavage, S_2 which overprints an older schistosity, S_1. The
older schistosity may be parallel to the axial plane of the
Quantico syncline. Porphyroblasts of staurolite and garnet
post-date S_1, but pre-date S_2. A sub-horizontal fracture
cleavage and schistosity, S_3, is evident in the granodiorite
and adjacent amphibolite. S_3 is parallel to axial surfaces
of small recumbent folds in the amphibolite, and F_3 fold
axes are parallel to a strong mineral lineation in S_3 in the
granodiorite gneiss. S_3 and L_3 are probably coeval with
intrusion of the granodiorite.

DISTRIBUTION OF LITHOFACIES AND DEPOSITIONAL ENVIRONMENTS
IN MIDDLE ORDOVICIAN CARBONATES (NEW MARKET, LINCOLNSHIRE
AND EDINBURG FORMATIONS) TUMBLING RUN SECTION, STRASBURG,VA.
Diana Morton*, Dept. of Geology, James Madison Univ.,
Harrisonburg, Va. 22801

This study is a statistical and petrographic analysis of
the lithofacies and depositional environments of the above
formations with models for their paleoenvironmental
relationships.

The New Market Fm. has three successive, overlapping
lithofacies indicating tidal flat, transitional intertidal,
and subtidal environments. Modeling of these lithofacies
produces a transgressive marine sequence. The New Market Fm.
ends with a distinct erosion/solution surface. The overlying
Lincolnshire and Edinburg Fms. are time-stratigraphic units
and represent continuous deposition with trends of decreas-
ing grain size, progressive darkening, and increasing shale
content. Four successive lithofacies are recognized indicat-
ing a transitional restricted environment, talus debris from
a reef-like organic mound, a transitional sequence, and a
subsiding shelf environment. Modeling of these lithofacies
produces a transgressive sequence reflecting basinal deepen-
ing and a rising terrigenous, clastic source.

The section is therefore interpreted to represent a
transgression of carbonate lithofacies in response to basinal
deepening which took place in conjunction with progressive
subduction characteristic of the middle to late Ordovician
Taconic Orogeny.

RECONNAISANCE OF THE IGNEOUS AND METAMORPHIC GEOLOGY OF THE
PAMPLIN, PROSPECT AND FARMVILLE QUADRANGLES, VIRGINIA.
Sean C. Murphy*, College of William and Mary, Williamsburg,
Va. 23185

Reconnaisance geologic mapping was conducted across the
crystalline rocks of the northern halves of the Farmville,
Prospect and Pamplin quadrangles in the central Piedmont of
Virginia. Silvery gray to green phyllites and schists of
the greenschist facies in the western half of the Pamplin
quadrangle resemble rocks of the Candler Formation mapped
to the northeast in the Dillwyn quadrangle by Brown in 1969.
The rocks in the eastern portion of the Pamplin quadrangle
and in the Prospect and Farmville quadrangles are similar
to those of the Hatcher Complex as described by Conley and
Johnson in 1975. These include quartz muscovite schist,
biotite schist, biotite gneiss, hornblende gneiss, amphib-
olite, quartzite, and kyanite quartzite. This complex has
been metamorphosed to the amphibolite facies. The kyanite
quartzite forms a resistant ridge on strike with the commer-
cial kyanite deposits at Willis Mountain and Baker Mountain.
Several pegmatite dikes and diabase dikes occur in the
three quadrangles. The rocks in the Pamplin and Farmville
quadrangles strike consistently northeast and dip south-
east. In the central Prospect quadrangle a more complex
structure is indicated by divergent foliation attitudes.

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MODELING FOR OVERTHRUSTS AND RELATED PHENOMENA.
N. G. Simmons*, D. G. Manweiler*, Dept. of Geological
Sciences, Va. Polytechnic Inst. and State Univ., Blacks-
burg, Va. 24061

Two important factors which influence the behavior of
rocks under compressive stress are the depth at which the
rock was deformed and the lithology of the rock unit.
Thrust faulting, created within a pressure box, illustrates
the mechanical principles underlying many geologic struc-
tures found in nature. The mechanics of deformation, based
on the laws of physics, are invariant and apply equally on
large and small scales. Successful analogs depict geologic
structures. An overthrust is a structure which readily
lends itself to intergranular movement and is best studied
by that vehicle; our experimental premise is based on the
difference in intergranular characteristics of the materials
involved and their positions relative to one another. Thin-
skinned geologic concepts, detachment in incompetent zones,
ramp height relationships, and style of deformation come
into play when the stratigraphic column of the model is sub-
jected to compressive stress.

The development of thrust faults and the ensuing dis-
placement along respective fault zones is determined by the
salient fault; should an overthrust belt be stalled, the
compressive stress on the footwall block will increase and
initiate further thrusting. Consequently, the newest faults
will show greatest displacement with continued stress, while
older faults will experience almost no further slippage.

PRELIMINARY REPORTS ON THE SALTVILLE PLEISTOCENE BONE BEDS: REGIONAL GEOLOGY AND GEOMORPHOLOGY. Jan Stocking*, John Thompson*, and Charles S. Bartlett, Jr. Dept. of Geology, Emory & Henry College, Emory, Virginia 24327

The brinefield area of Saltville, VA is underlain by shale and evaporites and is bounded on the north by limestone, shale and sandstone, all of Mississippian age. On the south are Cambrian and Ordovician carbonates and shale. Prominent structural features include the Greendale Syncline and the Saltville thrust fault.

It was determined that a rapidly flowing stream occupied this valley in Pleistocene time. Evidence includes crossbedding, rounded pebbles, lack of intrabasinal source for some pebbles, lack of rounded pebbles in present basin streams, and the scattered and disarticulated bones. A study of pebble composition indicates these formations as sources: algal chert, Honaker Formation; oolitic chert, Copper Ridge Formation; sandstone and siltstone, Price Formation.

There are two possible origins for this stream. The North Fork of the Holston River may have entered the valley through one or both gaps to the north of town and exited along Mc-Henry Creek. This is unlikely since the exit is 80+ feet higher than the entrance. It is more probable that drainage to the south of the area flowed to the northeast, emptying into the North Fork Holston River through the two gaps at Saltville. Recent piracy has modified the upper stream course by diverting McHenry, Keywood and Stonemill creeks.

THE FARMVILLE TRIASSIC BASIN: AN INTEGRATED GEOLOGICAL/ GEOPHYSICAL STUDY. Gerald P. Wilkes and David K. Lasch*. Va. Div. of Mineral Resources, Charlottesville, Va. 22903

Two geologic cross-sections of the Farmville Triassic Basin are proposed based upon two-dimensional gravity modeling and geological implications. Two gravity surveys with station spacing ranging from one-quarter mile to one mile were conducted along US 60 and SR 636 in Buckingham and Cumberland Counties, Virginia. Fifty-nine gravity stations were occupied. Density values were obtained from rock samples collected adjacent to and within the basin. Traverses along US 60 and SR 636 provided profiles nearly perpendicular to the strike of the Triassic sediments.

The US 60 traverse (northern profile) crossed the basin where the surface outcrop of Triassic sediments is relatively narrow whereas the SR 636 traverse (southern profile) crossed a wider and more diverse group of Triassic sediments. The Piedmont crystalline rocks surrounding the Triassic sediments were assumed to be similar for both profiles.

Investigations imply a complex fault system associated with the paleodeposition of Triassic sediments. A high-angle western border fault has been documented and supported by the presence of fanglomerates and arkosic sandstones. A western border fault is included in both gravity models. The gravity model of the northern profile indicates a system of faults at the eastern border of the basin. Gravity modeling of the southern profile indicates a fault at the eastern margin of the basin.

PRELIMINARY REPORTS ON THE SALTVILLE PLEISTOCENE BONE BEDS: 1978 EXCAVATION AND RESULTS. R. Stephen Surbaugh* and Charles S. Bartlett,Jr., Dept. of Geology, Emory and Henry College, Emory, VA, 24327.

Excavations in Fall, 1978 at Saltville, VA encountered a late Pleistocene Age vertebrate bone-gravel bed in six test sites at depths to seven feet. Ray (1967) obtained a radiocarbon date of 13,460 plus or minus 420 years (11,510 B.C.) from a tusk fragment excavated nearby in 1967.

Examples of Proboscidean, including Mammuthus americanum (American Mastodon) and Mammuthus primigenus (Wooly Mammoth), were numerous. Of the 1401 total recovered remains, 1039 are Proboscidean bone, teeth and tusk fragments. Other animals represented are listed in decreasing order of recovered remains: Equus sp. indet.(horse), Odocoileus virginianus (deer) or Rangifer (caribou), Bootherium (musk-ox), Megalonyx jeffersoni (ground sloth), and turtle fragment.

The deposit consists of disarticulated bone fragments (generally badly worn and rounded), mixed with highly rounded chert, limestone, and other rock pebbles, sand, clay, and silt. The formerly porous bone (carbonate-apatite or fluorapatite) has been permineralized with aragonite, calcite, and iron sulfide. No evidence was found of previously speculated in-situ death assemblages associated with nearby salt springs. The badly worn remains indicate that they have been transported from considerable distance upstream, suggesting the probability of other floodplain bone deposits in parts of the ancient valley.

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SUBCRITICAL CRACK GROWTH IN ASTM A 106 PIPELINE STEEL, T. A. Adler*, M. R. Louthan, Jr., and R. P. McNitt, Mat. Eng. & ESM, VPI, Blacksburg, VA 24061

Crack propagation tests with compact tension samples of ASTM A 106 pipeline steel in gaseous oxygen and hydrogen show that hydrogen increases the ease of crack growth, causes a change in the mode of failure (from microvoid coalesence to a cleavage-like failure) and decreases the critical J integral (fracture toughness). A significant amount of plastic deformation occurs prior to and during crack growth in hydrogen, but the amount of plastic deformation is much less than in oxygen. Even though the amount of plastic deformation prior to crack growth is reduced by the presence of hydrogen, hydrogen has relatively little effect on the load-displacement curve and the size of the Luders strain regions surrounding the crack tip until crack growth initiated. This indicates that hydrogen effects are localized to the near crack tip region.

A PHOTOELASTIC METHOD FOR THE STUDY OF WATER DIFFUSION IN DENTAL COMPOSITES. R. E. Barker, Jr., F. E. Wawner, Jr., O. C. Hodgins, and K. R. Lawless, Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

A study has been undertaken to utilize changes in optical birefringence to determine the effects of absorption and diffusion of water into a commercially available BIS-GMA (adaptic[R]) resin-quartz composite and on an experimental BIS-GMA resin. Observations with the polarizing microscope show that extensive changes in colored birefringence patterns occur near the edges and about defects in samples. The changes are dependent on time and temperature and represent related changes in the residual stress field. A relatively sharp colored boundary about $\frac{1}{2}$ mm wide appears around the edge of the sample, often involving nearby voids.

At $37^{\circ}C$ the sorption data indicate that $D \approx 4.92 \times 10^{-2}$ $b^2/t_{0.5} \approx 4 \times 10^{-11} m^2/sec.$, where $t_{0.5}$ is the time at which the water sorbed is half the equilibrium value. Typically the equilibrium water sorption observed from this experiment is about 0.8%. The methods for analyzing the diffusion data were similar to those described by Crank, Jain, and Barker.

Further experiments to refine the techniques and determine the possible effects of swelling on D are underway.

IN-SITU HVEM TENSILE TESTING OF HE IRRADIATED 316 SS AT LOW STRAIN RATES. J. I. Bennetch, J. A. Horton, and W. A. Jesser, Materials Science Dept., Univ. of Va., Charlottesville, Va. 22901

In order to investigate the effect of helium on the fracture of 316 SS, in-situ HVEM tensile studies were conducted on samples as they were being irradiated, to high helium doses (>.2 atom fraction) and at high temperatures ($^{\geq}600^{\circ}C$). These samples, tested at $600^{\circ}C$ and at strain rates $\leq 10^{-4}$ sec^{-1}, had a large helium bubble population produced by irradiation. Under an applied stress, cracks characteristic of both relatively ductile or brittle behavior were observed to grow. Typically it is found that a loss of ductility in 316 SS occurs upon helium irradiation to much lower doses (10^{-5} atom fraction) when tested at similar test temperatures ($700^{\circ}C$) and strain rates ($4x10^{-4}sec^{-1}$). Dislocations apparently sweep bubbles from the grain interior towards the grain boundary thereby weakening the samples at these low strain rates. Bennetch and co-workers observed not only an increase in bubble population on grain boundaries as irradiation progressed, but also in slip bands in front of a crack tip, suggesting brittle behavior. In addition, a decrease in bubble population in areas of plastic deformation in front of some crack tips was observed in the same sample, suggesting perhaps more ductile behavior. Crack propagation mechanisms for these phenomena will be discussed. (Supported by a grant from DOE.)

SIMULATION OF HIGH PRESSURE HYDROGEN ENVIRONMENTS BY CATHODIC CHARGING TECHNIQUES, W. H. Buttrill*, and M. R. Louthan, Mat. Eng., VPI, Blacksburg, VA 24061

Efficient and safe utilization of materials for the transportation and storage of gases containing hydrogen dictate the development of safe, convenient and effective test methods for characterization of candidate materials in hydrogenous environments. Testing methods currently employed to measure the environmental effects of hydrogen use high pressure gaseous systems which are necessarily large, costly and require extensive safety provisions. These test constraints can be avoided by the simulation of gaseous hydrogen at the surface of metals by the electrolytic evolution of hydrogen, H, thus producing high effective hydrogen pressures. An experimental test facility has been constructed in which electrolytic evolution of hydrogen is occurring simultaneously on the surfaces of a tensile specimen and a permeation membrane of the same material within the test cell. The test cell is integrated with a tensile testing machine enabling the measurement of mechanical properties of the tensile specimen during electrochemical charging. The permeation rate of hydrogen through the membrane is measured and shown to be equivalent to an effective pressure of gaseous hydrogen. Initial tests have shown that the system has several distinct advantages. The effective hydrogen pressures attained by these techniques exceed those readily obtained by conventional techniques. The complete test cell can be constructed and operated at a minimal expense and is quite safe because the small volumes of hydrogen gas which are evolved.

THE EFFECTS OF MOISTURE ON THE DYNAMIC BEHAVIOR OF GRAPHITE EPOXY COMPOSITES. E. T. Camponeschi*, and W. W. Stinchcomb, Department of Engineering Science and Mechanics, Va. Poly. Inst. and State Univ., Blacksburg, Va. 24061.

The objective of this work was to determine the effect of moisture absorption on the dynamic response of graphite epoxy composite beams. Forced vibration tests were conducted in order to determine the storage modulus and damping ratio in the beams. These tests were performed for beam moisture contents ranging from 0 to 0.8 percent of the initial dry weight. The results indicate that the storage modulus is unaffected by moisture absorption, while in laminates that are matrix controlled, moisture increases the damping ratio.

FRACTURE CHARACTERISTICS OF Aℓ-Cu ALLOYS CONTAINING θ' AND θ PRECIPITATES. I. Chan, and H. G. F. Wilsdorf. Dept. of Materials Science, Univ. of Va., Charlottesville, VA 22901

The influence of the semi-coherent θ' and incoherent θ precipitates on the fracture behavior has been investigated through in situ experiments in a high voltage electron microscope (HVEM) and post fracture studies with transmission (TEM) and scanning electron microscopy (SEM). The findings showed that void initiation took place in the matrix as well as at precipitate-matrix interfaces. Crack growth was achieved by three dimensional void coalescence. Dislocation cells were present along the crack in the thicker regions above 400 nm. Structures bounded by zig-zag contours were observed at the fracture surface by TEM representing the last stage of the final separation. Beginning with a discussion of fracture surfaces as seen in the SEM, the results obtained from HVEM and TEM could be brought to bear on the fracture mechanism in precipitation hardened Aℓ-Cu alloys.

DIFFUSION COEFFICIENTS FOR LIQUID PbSnTe. Ivan O. Clark*. Flight Electronics Division, NASA, Langley Research Center, Hampton, Va. 23665

In the absence of convection, the primary material properties governing the time necessary to obtain steady-state growth of a crystal are the diffusion coefficients of the material. Research is underway in the Flight Electronics Division of NASA/Langley Research Center to determine the diffusion coefficients for the $Pb_xSn_{1-x}Te$ system in liquid phase. This research consists of determining the solutal diffusion coefficients by means of an isothermal modified-Löschmidt cell technique. The thermal (Soret) diffusion coefficients are also being determined by means of a modified Löschmidt cell in a thermal gradient.

This research is in support of experimental and theoretical research into the growth of semiconductor materials in a low-g environment which is presently underway in the Flight Electronics Division of NASA/Langley Research Center.

ACOUSTIC EMISSION: ITS OCCURRENCE AND CAUSE IN 7075 ALUMINUM. John C. Duke, Jr., Dept. of Engineering Science and Mechanics, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

During the quasi-static tensile deformation of 7075 Aluminum elastic strain energy is released periodically and may be detected nondestructively by means of acoustic emission sensors. The acoustic emissions however do not occur uniformly with deformation, but their occurrence is repeatable from test to test. A variety of heat treatment conditions have been examined and provide considerable insight into the possible causes of the emissions.

Considering the results of the acoustic emission monitoring in light of the results of fracture toughness investigations provides an explanation of the sources of these emissions. Distinct regions are apparent in the acoustic emission behavior which appear to result because of different emission sources. The findings support the contention that the emissions result from the fracture of inclusions as well as dislocation mechanisms. Such a detection capability emphasizes the potential of this monitoring technique for revealing the nature of the deformation process in materials.

This work was supported in part by the Air Force Office of Scientific Research (AFSC) United States Air Force.

INTERFACIAL VOID FORMATION IN BORON FILAMENTS. J.W. Eason*, and F.E. Wawner. Dept. of Materials Science, University of Virginia, Thornton Hall, Charlottesville, VA 22901

Boron filaments were annealed in various atmospheres and in vacuum (10^{-7} Torr). Relatively large axial contraction was observed during the annealing process. A dependence of contraction on concentration of oxygen in the atmosphere was found. This oxidation of the boron resulted in large void formation at the boron-tungsten boride core interface, suggesting the mechanism of vacancy diffusion to the interface.

HARDNESS OF POLYCRYSTALLINE STEEL WHISKERS GROWN IN VARIOUS MAGNETIC FLUXES. T. I. Ejim*, and H. G. F. Wilsdorf. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

Polycrystalline steel whiskers grown by chemical vapor deposition (CVD) in the presence of a magnetic field exhibit high strengths of up to 8GPa. One of the various parameters that could affect their strength is the magnitude of the magnetic flux during growth. This paper concentrates on the effect of the magnetic field strength on the hardness and strength of polycrystalline steel whiskers. A Riehle microhardness tester was used in obtaining the Vickers hardness reading of batches of whiskers grown in different magnetic field strengths. The reading increased with an increase in magnetic field strength up to about 1200 gauss. However, the data showed a moderate decrease with the flux increasing to 2200 gauss. It was also found that the hardness of the whiskers showed no dependence on diameter over the range of diameters investigated (5 μm to 60 μm). The strength of the whiskers was deduced from hardness readings using the Cahoon hardness-strength relationship $\sigma = H/2.9$ where σ is the ultimate tensile strength and H is the Vickers hardness.

THE CATALYSIS AND INHIBITION OF THE THERMAL OXIDATION OF GRAPHITE FIBERS. B. M. Ence*, D. M. Esterling*, The George Washington University/JIAFS, NASA Langley Res. Ctr., Hampton, VA 23665.

At the upper service temperature of polyimide composites (644°K) some commercial graphite fibers oxidize readily while others remain very stable. The reasons for these differences were studied and a simple procedure to stabilize the fibers was developed.

Previous correlation studies indicated that residual sodium (a known catalyst for graphite oxidation) in the fibers and possibly the degree of graphitization of the fibers determined their stability. Tests were performed on Hercules AS (an unstable fiber) and HTS (a stable fiber) which seemed to verify the correlation studies.

Phosphorous and its oxides inhibit the oxidation of graphite. In this study a treatment with H_3PO_4 was developed which substantially decreased the oxidation rate of both the stable and unstable fibers, e.g. a factor of 20 reduction for the AS fibers at 755°K.

STUDY OF THE MELTING BEHAVIOR OF SMALL BISMUTH CRYSTALLITES. W.W. Gile* and W.A. Jesser. Dept. of Materials Science, University of Virginia, Charlottesville, Va.   22901.

An experimental study of size-dependence of melting has been ongoing for over 20 years by different investigators. As technological advancements permitted, improvements in the techniques of investigation have occurred. In this vain, this research is performed in a good vacuum ($2x10^{-7}$ torr) using in-situ evaporation. The melting of individual particles was detected by dark-field electron microscopy. When a particle melts, it will lose its crystalline structure and therefore its dark-field image will disappear. The experiments were performed as follows: the sample was heated taking micrographs at particular, known temperature intervals until all the particles have melted. These micrographs were analyzed by two different methods to ascertain explicit results on the melting temperature of the particle versus the inverse particle radius. The results from these two methods for bismuth will be compared along with the effect of oxidation on the results. The present results for bismuth will also be compared with those of other investigators of bismuth along with an explanation of the discrepancies between them.

A TENSILE TESTER FOR GLASS FIBERS WITH CONTROLLABLE ENVIRONMENT. Hilary T. Godard* and H. G. F. Wilsdorf. Dept. of Materials Science, Univ. of Virginia, Charlottesville, Va. 22901

The need arose for a device to produce and tensile test thin glass fibers in a variety of environments. A technique was developed for thin fiber production by remote control. Combined with a small load tensile tester of unique design, peripheral electronics, and plumbing, this machine fulfilled the requirements. In line with research goals, the capability of metalization was added. Applications involve investigation of water vapor degradation of glass fiber strength, and possible barriers to this degradation.

A NOVEL METHOD OF FINDING BOILING POINTS FROM van der Waal's GAS CONSTANTS. P. B. Haney* and W. A. Jesser. Dept. of Materials Science, Univ. of Va. Charlottesville, Va. 22901

This Method involves taking van der Waal's Equation of State, $P=RT/(V-b) - a/V^2$ where usual notation is employed, and setting the equation in the cubic form in V.

The combination of coefficients of the cubic equation which tests for the real or imaginary character of the roots is called F and is too lengthy for inclusion here. When this function F is negative there are three real and unequal solutions for the molar volume V. It was found that even though the purpose of F is to characterize the roots, V, it also determines the boiling temperature T.

The most negative value of F corresponds to a relative minimum when F is plotted as a function of T. This relative minimum determines the boiling point of the liquid at a pressure of 1 atmosphere. The explicit solution for T which minimizes F is given by: $T=[a/(2bR)-6bP/R+((6bP/R -a/(2bR))^2-(6bP/R)^2+60aP/R^2)\cdot{}^5]/6$ A comparison between this Method and the rule of Guldberg, $T=(2/3)x8a/(27bR)$ will be presented. For van der Waal's bonding and small values of a, the above Method is accurate to less than $\pm$ 0.5 degrées Kelvin.

MICROSTRUCTURAL ASPECTS OF SEMI-BRITTLE FRACTURE OF BERYLLIUM CRYSTALS. D. E. Hedke* and H. G. F. Wilsdorf. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

Mechanical testing at room temperature of beryllium single crystals oriented to exclude basal slip, in conjunction with post fracture examination by scanning and transmission electron microscopy (SEM and TEM) has defined the occurrence of a ductile to brittle transition dependent on the rate of elongation in tension. The semi-brittle regime occurs essentially at rates of elongation less than about .05cm/min ($8.333x10^{-4}$cm/s) and is characterized by fracture through well defined prismatic ligament separation. Above this elongation rate fracture generally occurs through cleavage on the $\{10\bar{1}0\}<11\bar{2}0>$ systems. TEM characterization strongly indicates volume element rotation about an axis perpendicular to stress axis as well as severe lattice distortion in interligament regions. The ductile to brittle transition is quantitatively defined on the basis of variation of the stress hardening exponent, n, as it occurs in the relationship $\sigma=K\epsilon^n$. σ,ϵ refer to true stress and true strain and K is the strength coefficient.

COMPRESSIVE STIFFNESS AS A MEASURE OF DAMAGE IN GRAPHITE EPOXY LAMINATES. A. L. Highsmith*, and K. L. Reifsnider, Department of Engineering Science and Mechanics, Va. Polytechnic Inst. & St. Univ., Blacksburg, Va. 24061

Previously, tensile stiffness has been related to damage in graphite epoxy laminates. This study examines the effect of damage on compressive stiffness. Varying degrees of damage were introduced into specimens via quasi-static and fatigue loading. Replication was used to characterize the damage state, and tensile and compressive moduli were measured. The effects of stacking sequence and damage on out of plane behavior, specifically elastic instability, are also examined.

RADIATION DAMAGE IN HE BOMBARDED STAINLESS STEEL THIN FOILS. L.L. Schiestle Horton* and W.A. Jesser. Dept. of Materials Science, U. of Va., Charlottesville, Va. 22901.

In-situ helium ion irradiation experiments on thin foils of type 316 stainless steel, a candidate first wall material for proposed fusion reactors, have been conducted by means of a 200 kV light ion linear accelerator mechanically linked to the objective lens of a 500 kV HVEM. An ion energy of 80 keV, ion fluxes up to about $2x10^{15}cm^{-2}sec^{-1}$, doses up to about $2x10^{18}cm^{-2}$ and sample temperatures ranging from about 500° C to 650° C were employed. In these experiments, the radiation damage process, including the onset of surface damage, was observed. In the lower temperature cases, the predominant type of surface damage was exfoliation. In the electron transparent regions of the samples, exfoliation usually occurred in circular patches. The patch diameter decreased with decreasing sample thickness. Exfoliation was observed on the front surface of the samples in regions of sample thickness of about 150 nm, which is less than the 281 nm projected helium range. In higher temperature cases, the predominant type of damage was blistering. In the electron transparent regions, blisters were observed to form in the thicker areas and buckled grains in the thinnest areas. Post-irradiation SEM examination showed the progression of damage from the electron transparent regions to the bulk areas was: buckled grains, blisters on the beam exit surface, blisters on both surfaces and, in the bulk areas, blisters on the front surface only. (Supported by D.O.E.)

DIFFUSE STREAKING IN TEM DIFFRACTION PATTERNS FROM PbSnTe. R. W. Housley* and W. A. Jesser. Dept. of Materials Science, Univ. of Va. Charlottesville.

Single crystal samples of stoichiometric PbSnTe were electropolished for transmission electron microscopy. Diffraction patterns of samples tilted to several different orientations show the NaCl structure. Also observed in the diffraction patterns are anomalous diffuse streaking and a number of extra diffuse spots which can be interpreted in terms of {100} sheets of intensity and relrods of intensity along the ⟨100⟩ directions of the bcc reciprocal lattice. The intensity of the diffuse relrods is high at cube corners and low at the cube center. In all diffraction patterns observed only two of the three possible {100} planes exhibited streaking in the diffraction pattern. The third streaking direction was always the one corresponding to the particular {100} plane which makes an acute angle of less than 55° with the plane normal to the electron beam. Some diffuse spots were selected to produce dark field images. Only general areas of intensity and extinction contours were visible in these dark field images. It is therefore likely that the relrods are produced by thermal diffuse scattering rather than plate-like precipitates or other usual origins.

The support of NASA is gratefully acknowledged for this project.

POINT DEFECT NUCLEATION THEORY. R. A. Johnson, Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

The theory for nucleation and growth of point defect clusters is commonly developed using a continuous size variable and continuous kinetic parameters. In the present work, the atomistic nature of the process is studied by writing a separate rate equation for each size cluster of irradiation-produced vacancies and self interstitials (up to a given maximum size for the model) and solving the ensuing set of coupled rate equations using computer techniques. The explicit system used as an example involves the nucleation and initial growth of clusters of inter-stitials at the onset of specimen irradiation. Both homogeneous and heterogeneous nucleation are treated, the latter by including trapping sites in the model, i.e., solute atoms with a binding energy for the mobile point defects. It is found that over a broad temperature range there should be appreciable nucleation of interstitial clusters in the transient period prior to the approach of single vacancy and interstitial concentrations to their approximate steady-state values.

(Work supported by the NSF through Grant No. DMR 78-07539)

LATTICE IMAGE STUDIES OF DENTAL ENAMEL. A. F. Marshall and K. R. Lawless, Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

Lattice imaging techniques with the TEM have been used to study the central defect often observed in crystals of hydroxyapatite from dental enamel. The central defect was resolved as a (100) lattice fringe in both longitudinally and crosscut crystallites, indicating a planar defect. The defect is of a phase nature and does not show diffraction contrast. Microdiffraction studies show the presence of hydroxyapatite only. Observations of lattice images from carious crystallites indicate the central defect in a site of caries attack.

INTERFACIAL ADHESION IN DENTAL COMPOSITE SYSTEMS. C. M. Montes-Gonzalez* and F. E. Wawner, Jr., Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

Glass reinforced resins used in dental restorations undergo severe thermo-chemical variations in environment. This study concentrates on the effects by temperature and water on the interface between a commonly used resin (BIS-GMA) and a surface of nearly pure fused quartz. The debonding shear strength is measured with an Instron tensile tester from single "fibers" embedded in a button of the res-in. Tests are made on samples immersed in water at 0°, 25°, and 80^oC for an extended time (20 days), and on samples thermocycled in water and in a desecator (dry) from 0^oC to 80^oC. The results are compared with the results of tests on samples prepared and tested at room-environmental conditions (T = 25^oC). The interface is varied by changing the surface pre-treatment of the fibers. A silane coating is applied in two different ways, one using n-propylamine as a catalyst, and another, more common in industry, using acetic acid in an aqueous solution. A varying amount of silane on the interface is achieved by using various times for treatment.

This study was supported by NIDR Grant No. DE 03925-04.

DISK RUPTURE TESTING FOR HYDROGEN EMBRITTLEMENT, J. Murali*, M. R. Louthan, Jr., and R. P. McNitt, Mat. Eng. and ESM, VPI, Blacksburg, VA 24061

Pre-flawed specimens of AISI 1015 sheet steel were subjected to biaxial loading using high pressure gas. Testing was done to investigate flaw growth behavior in hydrogen-carrying pipeline steels. Cicular specimens approximately 100 mm in diameter and 0.4 mm thick were subjected to internal pressure (oxygen or hydrogen) using the disk rupture technique. Bulge height and pressure were monitored using a LVDT and a high pressure transducer respectively. Gaseous hydrogen did not affect the pressure vs. bulge height curves even at large strains where for a given pressure, deflection in hydrogen was similar to that in oxygen. Hydrogen, however, lowered the rupture pressures by ∿ 15-20%. All samples tested in hydrogen failed by development of a pinhole at the flaw and did not rupture whereas many of the samples tested in oxygen ruptured. This feature indicated that hydrogen carring gas pipelines should leak before rupture which is safer than a catastrophic gas release. The results are correlated with tubular samples which developed similar leaks when subjected to internal pressure of hydrogen.

SOME EFFECTS OF GAS ENVIRONMENTS ON DEFORMATION AND FRACTURE OF POLYMERIC MATERIAL, T. E. Munns*, M. R. Louthan, Jr., D. Dwight and R. P. McNitt, VPI, Blacksburg, VA 24061
    Many structural metals are embrittled when pulled to failure in gaseous hydrogen. However, little information is available as to the mechanical behavior of polymers in the presence of hydrogen. Two polymers, one crystalline and the other amorphous were tested at various pressurizing rates in oxygen (control) and hydrogen to determine if hydrogen induced effects were apparent. The polymers were crystalline polybutylene terephthalate (PBT) and impact grade polystyrene (amorphous with dispersed rubber). When tested in air at atmospheric pressure PBT exhibited a high degree of plasticity as evidenced by necking before failure while the polystyrene was brittle and showed stress whitening. In oxygen, the fracture strength of both PBT and polystyrene increased with increasing strain rate. In hydrogen, the fracture strength of PBT increased with increasing strain rate while the fracture strength of polystyrene remained constant. There were no significant differences in deformation or fracture appearance between PBT tested in oxygen or hydrogen. The degree of stress whitening was much higher for polystyrene samples tested in a hydrogen environment as compared to those tested in oxygen. From these results it is apparent that in an amorphous polymer, such as polystyrene, hydrogen suppresses the effect of strain rate on the fracture strength. There is no apparent effect of hydrogen on the fracture of the more crystalline polymer.

HOLE-SIZE EFFECT IN COMPOSITES. R. Prabhakaran. Dept. of Mech. Eng. and Mechanics, ODU, Norfolk, Va. 23508.
    Hole-size effect in composites refers to the greater strength reductions in composites due to larger holes, the stress concentration factor remaining the same. Tensile tests have been conducted on a bidirectionally reinforced E glass-epoxy composite. Two series of tests have been performed, varying the width of the specimen along with the diameter of the hole in one and varying the hole diameter while keeping the coupon width constant in the other. An inherent size effect in the material, in addition to the hole-size, has been observed and taken into account in the data analysis.
    The "inherent flaw size" according to the fracture mechanics approach as well as the "characteristic dimension" according to the two-parameter models have been computed. Both the dimensions were found to be dependent on the hole size, increasing with increasing hole diameter. For the range of hole sizes tested, the characteristic dimension was found to be approximately half of the inherent flaw size.
    Surprisingly, in the literature on the hole-size effect in composites, no mention has been made on the notch-size effect in metals which has been extensively investigated. It is suggested that a similar attempt be made to relate the hole-size effect to the microstructure of composites.

REACTIONS BETWEEN ALUMINUM FILMS AND TITANIUM SUBSTRATES. V. B. Rao* and C. R. Houska, Dept. of Materials Engr., Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.
    Samples of 1 μm. Aluminum (Al) films, sputter-deposited on Titanium (Ti) substrates, were vacuum-annealed at 635°C for short times ($\frac{1}{2}$hr. and 1 hr.). X-ray diffraction analysis indicated that even after a $\frac{1}{2}$hr., Al totally reacted yielding a single phase layer of $TiAl_3$. The layer thickness was determined in each case from the attenuation of the integrated intensities from the Ti lines below the $TiAl_3$-Ti interface. Comparison with the equilibrium thickness calculated from a mass balance of Al. atoms, indicated a partial dissolution of $TiAl_3$ at the interface after it was quickly formed. Also, the diffraction lines from α-Ti were broadened by an Al composition profile extending into the Ti substrate.
    A computer program, modified for use with polycrystalline materials was used to simulate a diffracted intensity band for a Ti (101) reflection. The simulated band was made to match the experimentally obtained one, by varying the Al. composition profile. The final profiles contained a region near the $TiAl_3$ interface with a high composition gradient and a second region, where the composition gradient is small and the penetration distance is relatively large. The latter can be related to grain boundary diffusion.

FLUORIDE DETERMINATION IN DENTAL ALLOYS USING A RESONANT NUCLEAR REACTION. P.M. Natishan*(1), L.B. Johnson, Jr. (1) and R.O. Allen, Jr.*(2), Dept. of Materials Science (1) and Dept. of Chemistry (2), Univ. of Va., Charlottesville, VA

    In order to prevent the occurence of secondary caries, fluoride in various forms has been incorporated into dental alloys. Although the fluoride appears to decrease the incidence of secondary caries, it also leads to enhanced corrosion of the dental amalgams. Research continues in an effort to incorporate fluoride into dental alloys in a manner which does not interfere with the essential properties of the amalgam. Consequently, it has become desirable to develop a method for accurately determining the amount of fluoride in treated dental alloys.
    At the Univ. of Va., a microanalysis technique involving a resonant nuclear reaction was employed to analyze the fluoride content of treated dental alloys. Applying this technique to geological materials fluoride concentrations on the order of 1 ppm have been detected. In this analysis, high energy protons are used to bombard a sample initiating a variety of nuclear reactions including the pertinent resonant reaction for fluoride. This resonant reaction causes a series of nuclear decays emitting a characteristic γ-ray which can be measured. The yields, number of characteristic γ-rays detected per unit charge, of unknown and standard samples can be compared and the fluoride concentrations of the unknowns can be determined.

THE EFFECT OF HEAVY ION BOMBARDMENT ON NICKEL AND BINARY NICKEL ALLOYS. K. B. Roarty* and R. A. Johnson. Dept. of Materials Science, Univ. of Va., Charlottesville,Va. 22901

    The study of radiation damage of materials is a field of present and future concern in that reactor materials, when exposed to high doses of radiation can swell due to creation of voids and cause reactor failure. Short-term high energy ion bombardment has been used to simulate the long-term exposure and damage of reactor materials. In this study, nickel and binary nickel alloys of 1 at % Al, Ti, Si or Mo were bombarded by 2.8 MeV Ni^+ ions in a Van de Graaff accelerator at 675°C, 625°C, 575°C and 525°C. Using transmission electron microscopy, it was found that all additions suppressed void swelling, although the Si and Mo additions to a much greater degree. Peak swelling occurred at the higher temperatures, and high dislocation densities were found at the lower temperatures with dislocation structure progressing from loops and tangles to segregated line segments as the temperature increased.

(Work supported by ONR and NSF, Van de Graaff facilities provided by NRL)

RADIATION DAMAGE EFFECTS ON THE MICROSTRUCTURE OF NICKEL. M. L. Sattler* and W. A. Jesser. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901
    The microstructure of small-grained thin nickel films was studied by TEM techniques during and after bombardment with 80 keV He^+ ions in an effort to simulate the effect of the environment on first-wall fusion reactor materials. The samples were chemical-vapor-deposited nickel thin films obtained by the thermal decomposition of $Ni(CO)_4$. Their initial microstructure consisted of dislocations and twins in large (600 nm) grains surrounded by smaller (30 nm) grains.
    At low doses and dose rates (1.8×10^{17} ions/cm^2 and 7.1 $\times 10^{13}$ ions/cm^2-sec, respectively) there appeared no prominent damage; grain sizes and grain arrangements remained unaltered. At high doses and dose rates (1.3×10^{18} ions/cm^2 and 7.5×10^{14} ions/cm^2-sec, respectively) there was gross damage over the sample; small voids or bubbles decorated the grain boundaries while all shapes and sizes (10 to 200 nm) of cavities remained inside the grains; the area immediately next to the grain boundaries was denuded; no small grains remained, only large (800 nm) ones; grains with dislocations seemed to contain fewer cavities than those without dislocations. At intermediate doses and dose rates, damage was minimal; tiny cavities (~1.5 nm) appeared in the small grains; grain sizes and grain arrangements were unaltered. (Sponsored by a grant from DOE, Office of Fusion Energy.)

EFFECT OF SAMPLE THICKNESS ON DELAYED FAILURE HYDROGEN EM-
BRITTLEMENT, P. W. Smith*, M. R. Louthan, Jr., and R. P.
McNitt, Mat. Eng. & ESM, VPI, Blacksburg, VA 24061
    Sample thickness greatly influences the maximum stress
at which 4340 steel samples fail when loaded in a four
point bending fixture placed in hydrogen gas for a specific
time. Rectangular samples (1/2"x2"x0.05 to 0.10") were
stressed so that the top surface was in uniaxial tension
prior to the samples and loading fixtures being placed in a
high pressure autoclave. The autoclave was then evacuated,
flushed with purified hydrogen and pressurized to the
desired level (typically 2000 psi). Samples were exposed
at room temperature for 120 hours then checked for failure.
If failure had not occurred the samples were stressed to a
higher level and returned to the autoclave for another 120
hour exposure. This procedure was repeated until the
minimum failure stress was determined. Fresh samples were
then tested to be certain that cumulative exposure effects
did not distort the failure data. This data has shown that
the failure stress decreased with increasing sample thick-
ness, an effect which can be rationalized by a critical
ligament theory. This theory suggests that a critical
volume of steel must be at or above some minimum stress
level before hydrogen induced cracking can nucleate. For
the particular loading conditions tested, crack nucleation
is apparently rapidly followed by failure so no analysis of
crack propagation was attempted.

NONDESTRUCTIVE EVALUATION OF FATIGUE DAMAGE IN COMPOSITE
MATERIALS. P. C. Yeung*, M. N. Gibbins*, and K. L.
Reifsnider. Dept. of Engineering Science and Mechanics, Va.
Polytechnic Inst., Blacksburg, Va. 24061
    Flaw growth around an embedded flaw in the interior of a
composite laminate has been investigated. Various non-
destructive techniques, such as thermography, ultrasonics,
and X-ray radiography, were utilized to monitor the damage
development in these composites while under fatigue loading.
The information obtained provided a valuable insight in the
understanding of the complex nature and the extent of the
fatigue damage growth. The results were then compared with
sectioning studies, surface replication, and stiffness
change measurements. (Aided by NASA grant NSG-1364).

INSTRUMENTED IMPACT TESTING FOR ENVIRONMENTAL DEGRADATION OF
STEELS, S. M. Stafford*, and R. P. McNitt, Mat. Eng. and ESM
VPI, Blacksburg, VA 24061
    Mechanical properties such as strength, toughness and
ductility are typically functions of the rate of loading
(strain rate) of metals. Increasing the strain rate usually
decreases ductility and toughness thus "embrittling" a
material. The Charpy impact machine has been a convenient
means of obtaining material toughness at high strain rates
and the addition of an instrumented top, integrating and
recording devices provides a system to obtain load-dis-
placement history during very high speed tests.
    Hydrogen embrittlement in metals is commonly presumed
to be emphasized by very slow strain rate testing. This is
due in part to relatively slow diffusion of hydrogen to
high strain energy sites. However high strain rate embrit-
tlement may occur if the hydrogen were appropriately distri-
buted by pre-impact static straining. Hence an experimental
program involving a mild steel (A106) thought to be rela-
tively passive to hydrogen and high strength (4140) steel
known to exhibit hydrogen embrittlement was designed. The
Charpy impact specimens have three pre test conditions; 1)
no hydrogen-no preload, 2) hydrogen charged-no preload, and
3) hydrogen charged while-preloaded to near yield by a
static load configuration similar to the eventual dynamic
loading. In the latter configuration the static load is
removed just prior to testing. The stress strain curves,
max stresses, toughness and yield loads will be compared
for both materials and the three loadings to obtain evi-
dence of high strain rate hydrogen embrittlement.

Medical Science

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A SCIENTIFIC ANALYSIS OF "LIE DETECTORS" AS INSTRU-
MENTS FOR THE PSYCHO-DIAGNOSIS OF HUMAN STRESS AND
DECEPTION.   John C. Bartone and Michael P. Kradz,
American Health Research Institute, Annandale, Va.
22003.

A "science" of "lie detection" does not exist
and never has in the history of man. A few special-
ties prefer acceptance that "lie detection" is real,
practical and fearsomely revealing. No instruments
exist as "lie detectors." Furthermore, the sympto-
psycho-somato-plex or overall effects of such mach-
ines on populations remains real but unexplored.

Instruments labelled "lie detectors" or other
names as "voice analyzers" have one common attri-
bute: to measure or record physiologic activity of
various types as electro-dermal conduction or infra-
sonic vibrational voice structure. These functions
pertain to the mind/body or both as inverse psycho-
somatic phenomena.   Stress, with all its unknowns,
also creates physiologic fluctuations from somatic
causality or psychic stress, and its symptomology
adds to whatever aspect these devices divulge. The
lie detection industry effectuates its practice by
noting increased stress due to immoral behavior.
Gross malpractice of science and medicine abounds
with these devices. Consequently, the intricacy
of psycho-diagnosis of human stress and deceptive
practices remain idiopathic and semiological.

STUDIES OF A HUMAN ACARDIAC MONSTER. F.R. Bieber* and
W. E. Nance*. Dept. of Human Genetics, Med. Col. of Va.,
Richmond, Va. 23298

Acardia, the total lack of a heart, is an unusual malfor-
mation that is unique to the twinning process. It occurs
with an estimated frequency of about one in 100 twin pairs.
We report studies of one such case, ascertained when a non-
viable 322-gram malformed fetus was delivered as the second
member of a twin pair. The first twin was a normal male,
weighing 1967 grams at birth, and had no cardiac or other
problems in the perinatal period.

The acardiac twin was grossly amorphous, with absent
upper and malformed lower extremities, and a large omphal-
ocele. Dissection revealed the absence of the heart, lungs,
liver and kidneys, and presence of several isolated loops
of gut. Skeletal structures, where present, were hypoplas-
tic and malformed. The single gonad had failed to differen-
tiate sufficiently for histologic sex determination. No
other internal genital structures were found. The mono-
chorionic, diamniotic twin placenta had large artery-artery
and vein-vein anastomoses. The umbilical cord connected to
the acardiac twin was marginally inserted and had only two
vessels.

In only a few of the previously reported cases of acardia
have genetic studies, including chromosome analysis, been
conducted. Data from several genetic studies of this case
will be presented and discussed.

TOTALLY DISCONTINUOUS DNA SYNTHESIS IN TRANSFORMED HUMAN FI-
BROBLASTS. David E. Berry* and James M. Collins, Department
of Biochemistry, Medical College of Virginia Campus, Virginia
Commonwealth University, Richmond, Virginia 23298, USA

Normal diploid cells and their SV40-transformed counter-
parts represent logical systems for the study of the results
of cell transformation. When normal human diploid fibro-
blasts (WI-38) are pulsed with ^{3}H-TdR, the earliest detect-
able DNA synthesized is in the form of small, 4.5 S "Okazaki
fragments", which are subsequently converted to large (400
S) chromosomal-sized DNA. We have detected similar small
pieces of DNA in transformed WI-38 cells (called 2RA). When
both cell lines are pulsed for very short times, analysis by
alkaline sucrose gradient sedimentation reveals both radio-
active "Okazaki fragments" and larger radioactive DNA mole-
cules. However, the distribution of radioactivity between
small and larger pieces of DNA is quite different in the two
cell lines. Extrapolation of the data to zero time reveals
that the normal cell line contains 50% of the ^{3}H in DNA
pieces smaller than 6 S and 50% of the label in DNA pieces
larger than 6 S. The transformed cell line, however, con-
tains 67% of the ^{3}H in DNA pieces smaller than 6 S and only
33% of the ^{3}H in DNA pieces larger than 6 S. These data
argue that DNA synthesis in the transformed cells is totally
discontinuous whereas DNA synthesis in normal cells appears
to be semi-discontinuous. Supported by NCI grant CA-24158.

METHYLGLYOXAL CATABOLISM IN BLOOD. R. B. Brandt and
S. A. Siegel, Dept. of Biochemistry & MCV/VCU Cancer Center,
Va. Commonwealth Univ., Richmond, VA 23298

Methylglyoxal (MeG), a dicarbonyl has potential role
in growth inhibition. Catabolism of MeG occurs through the
glyoxalase enzymes consisting of glyoxalase I (S-lactoyl-
glutathione methylglyoxal lyase, isomerizing; EC 4.4.1.5)
and glyoxalase II (S-2 hydroxyacyl glutathione hydrolase; EC
3.1.2.6), with glutathione as a coenzyme to form D-lactate
(not the L-lactate of glycolysis). Due to the active gly-
oxalase system in many tissues, the direct determination of
MeG is difficult. However, the product of its catabolism,
D-lactate, may be measured to determine formed or exogenous
MeG. An enzymatic stereospecific spectrophotometric assay
involving reduction of NAD$^+$ was used for plasma D-lactate
analysis. In normal humans the plasma D-lactate concentra-
tion was found to be 0.02 mM. When the glycolytic pathway
in whole blood was inhibited in vitro with fluoride, a sig-
nificant increase in D-lactate was found. Added MeG also
caused increased formation of D-lactate. Specific glyco-
lytic intermediates added to whole blood produced an in-
creased plasma concentration of D-lactate, even when glyco-
lysis was not inhibited. These findings indicate that some
catabolites of glucose leads to MeG synthesis and suggest
possible control functions for the glyoxalase enzyme system
during impaired glycolysis that may be exploited for cancer
therapy. (Supported by funds from the National Foundation
for Cancer Research.)

HISTOCHEMISTRY AND ULTRASTRUCTURE OF RAT MASSETER MUSCLE AFTER LIDOCAINE TOXICITY. Francis M. Bush, Hugo R. Seibel and Melvin F. Dolwick. Div. of Occlusion and Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298

Lidocaine administered singly, subcutaneously or intramuscularly, into masseter muscle, induces a phase of degeneration lasting approximately two days followed by a return to the normal histology by about 45 days. The present paper describes the effect of intramuscular injection of 2% Lidocaine.

Myofiber enzymatic activity showed decreased phosphorylase, increased succinic dehydrogenase and increased adenosine triphosphotase (alkaline stable form ATPase). Damaged myofibers demonstrated leucine aminopeptidase and glucose 6-phosphate dehydrogenase activities that suggested autolytic processes involving macrophages. Leucine aminopeptidase was slightly present within fibroblasts. Glycogen, was absent from myofibers in early lesions but accumulated in adjacent myofibers.

Mitochondrial changes are related to increased succinic dehydrogenase activity while alterations of the sarcoplasmic reticulum correlates with phosphorylase disappearance. Myofibrillar disruption accounted for increased ATPase activity. Macrophage activity correlates with increased leucine aminopeptidase.

IN VITRO EFFECTS OF KEPONE. E. L. Carmines*, D. W. End*, R. A. Carchman*, J. F. Borzelleca. Div. of Toxicology, Dept. of Pharmacology, Med. Col. of Va., Va. Commonwealth Univ., Richmond, VA 23298

Kepone (10^{-8}M to 10^{-4}M) inhibited a number of basic cellular and biochemical responses. Using the P388D$_1$ cell line, an in vitro cell system was developed utilizing a mosaic of parameters (ie. cell proliferation, oxygen consumption, phagocytosis, and calcium metabolsim) as indicators of cytotoxicity. This cell line has been shown to possess many morphological and functional characteristics of macrophages. Kepone (1×10^{-4}M to 1×10^{-8}M) inhibited cellular proliferation (90 to 20%) and stimulated oxygen consumption (260 to 97%). The ability of the P388D$_1$ cells to phagocytize opsonized sheep red blood cells was initially enhanced followed by a depression over a four hour treatment period. Kepone produced a significant decrease in the size of the mitochondrial exchangeable calcium pool while increasing the efflux rate constant of that pool. The effects of Kepone on energy metabolism and calcium distribution may be facets of cellular events related to the observed in vivo toxicity. (Supported in part by EPA grant number R-804701010.)

OBSERVATIONS ON NORs, QM HETEROMORPHISMS AND SATELLITE ASSOCIATIONS IN TWINS: AN MZ TWIN PAIR WITH A 14/21 TRANSLOCATION. C. R. Casson* and J. A. Brown*. Dept. of Human Genetics, Med. Col. of Va., Richmond, Va. 23298

The presence of human chromosome heteromorphisms has proved useful in zygosity determination. A recently developed staining technique, Ag-AS, makes possible the observation of a heteromorphic region (nucleolar organizer region [NOR]) in the ten acrocentric chromosomes (Nos. 13-15 and No. 21 and 22) in man. Metaphase chromosomes from a monozygotic twin pair possessing a 14/21 translocation were stained by a modification of the Ag-AS technique, counterstained with quinacrine mustard dihydrochloride and scored for NOR activity, QM heteromorphisms and satellite associations. An analysis of the variation in NOR activity between and within individuals revealed no significant differences between repeated observations in each individual and the observations across the pair. Estimates of the variance components of NOR activity for each acrocentric chromosome in the twins revealed a smaller variance component between the individuals than between repeated observations. The regression line that best fit the data by the least squares method had a slope of 1.09 and an intercept of 0.05; the 95% confidence interval for these values included a slope of 1 and an intercept of 0. A Pearsonian correlation between the mean NOR scores of the twins' chromosome pairs was highly significant ($p<.01$) with a coefficient of 0.97. These preliminary results suggest that the degree of NOR activity is characteristic for a particular chromosome.

BRANCHED CHAIN AMINO ACID TRANSFERASE (BATASE) ACTIVITY IN SELECTED MURINE TUMOR MODELS. W. Chan* A.M. Kaplan, and W.L. Banks, Jr., Depts. of Biochem., Microbiology and Surgery Med. Col. of Va., Richmond, Va. 23298.

This study was designed to examine the activity (ACT) of BATase in four different murine tumors, Lewis lung carcinoma (LL), B$_{16}$ melanoma (B$_{16}$), MCA 2182 fibrosarcoma (MCA) and A$_{26}$ glioma (A$_{26}$), as well as in selected tissues (liver, muscle, kidney and brain) of the tumor-bearing host. Groups of 10 female C57B1/6J mice were inoculated S.C. on the flank with 5×10^5 trypsinized viable cells from each tumor line. BATase measurements were carried out on all tissues 18-20 days after the inoculation of the tumor cells. BATase was assayed in a media containing LEU, mercapto-ethanol, αKG, pyridoxal phosphate, and potassium pyrophosphate buffered at pH 8.2. BATase ACT was expressed as μm keto LEU formed/gm tissue. The results showed that among the tumors, LL had significantly higher and B$_{16}$ had significantly lower BATase ACT than the other tumors. With the host tissues, all organs except the brain in the LL mice showed significantly higher BATase ACT than the comparable tissues of the control nontumor bearing mice and there was no difference in the tissues of the MCA mice as compared to those of the control. BATase, being the first enzyme in the catabolism of branched-chain (BCAA), these data offer indirect evidence that BCAA metabolism might be altered in tumors and the host tissues. (Supported by ACS IN-105D.)

DRUG-INDUCED ALTERATIONS ON GROWTH AND DEVELOPMENT: NEUROENDOCRINE AND PHYSIOLOGICAL ASPECTS. M. Ching, Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298

Chronic feeding of saline or D-Amphetamine sulfate (AS, 1-5 mg/kg/day) or injection of codeine phosphate (CP) or phenobarbital (PB) (both 30mg/kg/day) to pregnant and lactating rats resulted in abnormal growth and development of male and female offspring. CP or the high dose of AS caused stunting of fetal growth. Conversely, feeding saline or low doses of AS enhanced somatic growth. The perinatal mortality rate was increased in litters of mothers administered CP, PB or AS. Precocious or delayed vaginal opening occured in daughters of PB or AS-treated mothers, respectively. PB stimulated somatotropin releasing activity in hypothalami of newly weaned neonates without altering somatotropin release inhibiting factor (SRIF) stores. Pituitary and serum concentrations of somatotropin (STH) remained unchanged or declined following PB or CP treatment but STH stores increased after puberty. Offspring of saline-fed mothers showed increased hypothalamic content of SRIF and decreased luteinizing hormone releasing hormone stores coupled with an apparent rise in pituitary and decline in serum STH titers. Thus, the chemical agents employed in this study altered certain anatomical and physiological parameters associated with growth. This reiterates the need for proper control of diet and intake of medication during pregnancy. (Aided by grants from the Human Growth Foundation and AM 16557).

AN INTEGRATION OF RETROGRADE PEROXIDASE AND GOLGI TECHNIQUES FOR THE EVALUATION OF NEURONAL MORPHOGENESIS AND SYNAPTOGENESIS. C.W. Christman, J.T. Povlishock*, Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298

The study of morphogenesis within both the developing and maturing nervous system has long been problematic due in part to the difficulty encountered in the ready and precise recognition of specific nuclear complexes. The present investigation reports a new protocol that minimizes these difficulties. In this current report we consider the maturation of the rat hypoglossal nucleus. To precisely identify this nucleus the tongue musculature of neonatal rats was injected with a 10% solution of horseradish peroxidase (HRP) in a 2% solution of DMSO. After a brief survival the animals were perfused and their brains were serially sectioned on a Vibratome. The serial sections were collected and processed for either the light or electron microscopic visualization of HRP. At the light microscopic level the reaction product was intense and thereby allowed for the ready visualization of the maturing neuronal somata and dendritic appendages. Concommitant Golgi studies confirmed that the morphological features seen with HRP were consistent with those shown with silver impregnation. Of further benefit was the finding that when the adjacent serials were studied at the electron microscopic level, the protein tracer could again be identified and thus a specific hypoglossal neuron could undergo detailed ultrastructural analysis.

COMPARISON OF NUCLEAR NONHISTONE POLYPEPTIDES BY LIMITED PROTEOLYSIS. D. L. Cochran* and K. R. Shelton, Dept. of Biochemistry, Med. Col. of Va., Richmond, VA 23298

Neither the structure nor the function of most nuclear nonhistone proteins is well understood. Properties of several chicken erythrocyte nuclear polypeptides including abundance, solubility and ease of polymer formation indicate that these polypeptides may have a structural role in the cell nucleus. In a further effort to characterize these polypeptides, nuclear nonhistone proteins were isolated and subjected to limited proteolysis by incubation with each of three enzymes: papain, chymotrypsin and staphylococcus aureus protease. The polypeptides yielded several abundant common peptide fragments as well as lesser amounts of identical and nonidentical fragments. These results demonstrate that the purified avian erythrocyte nuclear nonhistone polypeptides share amino acid sequences. The extensive sequence homology indicate that these nonhistone polypeptides have related structural roles. (Work supported by grant number CA15923, awarded by the National Cancer Institute, DHEW.)

UNOXIDIZED AND OXIDIZED ISOPROTERENOL-INDUCED MYOCARDIAL CALCIUM CHANGES AND PATHOLOGY. T.W. COFFEY*, J.L. Poland, F.O'M. Shiel*, and K.C. Corley, Dept. of Surgery, Med. Col. of Va., Richmond, Va. 23298

Unoxidized isoproterenol (UISO) produces subendocardial pathology which has been ascribed to hypoxia rendered by an inadequate coronary blood flow to suffice the chronotropic and inotropic effects of UISO. However, oxidized isoproterenol (OISO) produces more severe pathological changes than UISO. Some data suggest that an isoproterenol-induced elevation of intracellular calcium (Ca) is also involved in myocardial pathology. The present study investigates in the rat the mechanism by which UISO- and OISO- induced Ca changes may mediate myocardial pathology. The effects of UISO and OISO (50 mg/kg s.c.) on total myocardial Ca, subendocardial and subepicardial sarcoplasmic reticulum (SR) uptake velocity and capacity were studied when injected alone and simultaneously with propranolol (β-adrenergic antagonist) or verapamil (Ca antagonist). Both UISO- and OISO- induced increased total Ca and differentially affected SR Ca uptake velocity between the subendocardial and subepicardial. While the OISO changes were reduced by propranolol or verapamil, only verapamil blocked OISO changes. Although isoproterenol toxicity may be Ca mediated via β-receptors, the oxidized products of isoproterenol may produce their effects via Ca mediation at some site other than the β-receptor (Aided by NIH grant HE 13454).

SPECTROPHOTOMETRIC ABSORBANCES OF BLOOD PLASMA IN NUTRITIONAL PROFILES. G. Colmano, Veterinary Medicine, VPI & SU, Blacksburg, VA 24061

Blood plasma of animals has absorption peaks in the 180-220 nm region for dipeptide bonds, at 280 nm for aromatic amino acid residues, and at 414 nm for porphin derivatives from hemoprotein of destroyed erythrocytes. The ratios of these absorption peaks have empirically indicated a close relationship with different nutritional protein levels. This relationship has been followed in several animal species under different experimental conditions. Rats on a protein deficient diet decreased the dipeptide bonds and the aromatic amino acid residues of proteins, and increased hemoproteins. Fifth generation mice and quail with chronic mercury poisoning exhibited a higher hemoprotein at 414 nm. Mice with growing sarcoma 180 ascitic tumors had changes in protein concentration in blood plasma and ascitic fluid that were followed during the development of the tumor to compare them to those of mice rejecting the tumor. Optimal energy utilization by feedlot steers separated into 4 groups of protein supplementation, and lactating cows on 2 levels of protein supplementation became clearly differentiated from the level of protein utilization calculated on the spectral absorbances at 205 nm, 278 nm and 414 nm. These results indicated that the spectrophotometric absorption technique presents a new and promising method for detecting levels of nutritional proteins in blood plasma.

BACTERIOSTASIS OF STAPHYLOCOCCUS AUREUS BY POSITIVE DIRECT CURRENT ACTIVATION OF METAL IONS IN MONOMOLECULAR FILMS ON INTRAMEDULLARY PINS. G. Colmano, S. S. Edwards, and S. D. Barranco*, Veterinary Medicine, VPI & SU, Blacksburg, VA 24061; Montgomery County Orthopedic Associates, Blacksburg, VA 24060

When solid silver pins were contaminated with ~3000 Staphylococcus aureus and placed either into agar or broth, or inserted into the femurs of rabbits, it was found that all 3000 bacteria could be eliminated by applying one hour of 12 μA positive direct current to the pins. As silver was too soft for practical use, silver electroplated stainless steel pins, or stainless steel pins coated with 100 monomolecular layers of silver stearate were substituted and achieved the same result. At this point, many different metal stearates were tried and it was determined that an equimolecular combination of silver and cerium stearate gave the best and most consistent bacteriocidal results. In the dog, while we could not induce an active form of osteomyelitis, we were able to markedly reduce the bacterial infection in the current treated ulnas as compared to the untreated ulnas. However, while the mechanisms underlying the bacteriocidal effect are still under investigation, this approach provides a useful method in the therapy of osteomyelitis in domestic animals.

ABSORPTION SPECTRA OF BLOOD PLASMA AND ASCITIC FLUID FROM MICE BEARING S-180 ASCITIC TUMOR CELLS. G. Colmano and G. G. Schurig*, Veterinary Medicine, VPI & SU, Blacksburg, VA 24061

Absorption spectra of blood plasma samples from random bred Dublin (ICR) mice were compared before and after intraperitoneal injection with viable Sarcoma 180 cells. Also, spectra of ascitic fluid, tapped from the peritoneal cavity containing the ascitic tumor, were compared. Absorption spectra scans of blood plasma and ascitic fluid from 180 nm to 700 nm had three major peaks at 188 nm, 278 nm, and 414 nm, indicating that blood plasma and ascitic fluid contained the same basic components. However, the ratios of the peaks revealed changes from the first to the third bleeding. These changes profiled the development of the tumor. Preliminary findings indicated that our technique is able to detect some characteristic changes in blood plasma and ascitic fluid of mice during the development of the tumor. In the animals capable of rejecting the tumor, the observed changes need to be studied further.

SCANNING AND TRANSMISSION ELECTRON MICROSCOPY OF DECIDUA-GENESIS IN THE IMMATURE RAT. S.S.Craig* and W. P. Jollie, Dept. of Anatomy, Med. Coll. of Va. Richmond, Va. 23298

Uteri of sexually immature rats are capable of responding to ovarian steroid hormones and of undergoing decidualization, an endometrial transformation which normally occurs in the adult rat during implantation. Decidualization can be induced experimentally in prepubertal rats which have been injected with ovarian hormones on a regimen shown to support implantation. Nineteen-day-old rats were bilaterally ovariectomized, and received 8 daily subcutaneous injections of progesterone and a single injection of 17-β estradiol on day 4 of progesterone treatment. To induce decidualization, sesame oil was injected into the right uterine lumen on day 5. The left uterus served as a control. The rats were killed on day 9, and uteri were removed, weighed and processed for electron microscopy.

Because of decidual growth, the right uteri increased in weight between 200 and 900 percent. With scanning electron microscopy, the luminal surfaces of epithelial cells of the control uteri were covered with abundant long microvilli; the epithelial cells of decidual uteri had increased in width or diameter and their surfaces contained fewer and shorter microvilli. With transmission electron microscopy, control epithelial cells were columnar and stromal cells resembled active fibroblasts. Luminal epithelial cells of the decidualized horn were squamous; and stromal cells exhibited features characteristic of decidual cells in adult animals.

PERSONALITY PROFILES OF ACUTE CARE AND NON-ACUTE CARE NURSES. L.J.Crosby, School of Nursing, Univ. of Va. Charlottesville, Va. 22901

This study investigated the question: are there significant differences in personality profile scores,(PPS), of nurses who select and subsequently practice for one yr. within acute care and non-acute care hospital units? The purpose was to develop a personality profile for each of these two groups. N=85 newly graduated nurses, $\bar{X}$ age 24yrs. Educ. prep., 67 B.S.N., 12 A.D.N. and 5 Diploma in Nursing. Subjects self-selected acute care or non-acute care work areas as first professional experience. During pre-employment orientation, subjects were tested utilizing the Adjective Check List (ACL) and California Psychological Inventory (CPI). Following one year of practice, subjects were retested. Mean scores of the 48 ACL and CPI profile traits were analyzed for between/within group differences and similarities. Subjects who remained within practice areas for one year were utilized to develop a composite profile of each group, N=38. Stat. significant between group differences were identified prior to and following one year of nursing practice. Based on this study, acute care nurses can be characterized as self-assured, dominant, adventurous individuals who avoid routine and seek out complex disordered environments. Autonomy is preferred within personal and professional situations. Non-acute care nurses are self-assured, stable, practical individuals who tend to avoid risk-taking situations. Close group affiliation is preferred in personal and professional situations.

A NEW PROTOCOL FOR THE PHYSIOLOGICAL AND MORPHOLOGICAL EVALU-ATION OF THE PIAL VASCULATURE AND ITS APPLICATION TO THE STUDY OF HYPERTENSION. W.D. Dietrich*, E.P. Wei*, J.T. Povlishock* and H.A. Kontos*, Depts. of Anatomy and Medicine, Medical College of Virginia, Richmond, Virginia 23298.

Scanning and transmission electron microscopy in conjunc-tion with physiological assessment were employed in the study of the pial vasculature following acute hypertension. Through such a regimen we have correlated the hypertensive functional alterations of the pial arterioles with those mor-phological alterations observed therein. To this end, the pial vasculature of 20 cats was prepared for direct visuali-zation via the insertion of a cranial window, and then sys-temic hypertension was produced by angiotensin infusion. When arterial blood pressure was elevated above 220mmHg for 15 minutes, the vessels displayed profound vasodilation. Following completion of the functional studies the physio-logically monitored vessels were identified with the use of a map previously drawn through the cranial window demonstra-ting the course of the vessels. These same vessels were then processed for routine scanning and transmission elec-tron microscopy. Scanning electron microscopy of pial arterioles demonstrated endothelial craters and balloons which corresponded to the endothelial surface indentations and cytoplasmic blebs recognized in these same vessels with transmission electron microscopy. The results of this study demonstrate that via the use of rigorous morphophysi-ological analyses, the morphological correlates of physiolo-gical vascular dysfunction can be identified.

EFFECT OF PROLONGED DIET RESTRICTION IN THE SPONTANEOUSLY DIABETIC MOUSE. B.A. Dore* and S.R. Webb, Biology Dept. Virginia Commonwealth Univ., Richmond, Va. 23284

The autosomal recessive gene, db, causes a spontaneous diabetes-like disease in the mouse strain C57BL/Ks. The hyperphagic mice became obese and exhibited hyperglycemia, glucose intolerance, glycosuria, and polyuria. Homozygous diabetic (db/db) and normal (+/+) mice were examined in this study. All mice were 25 day old males weighing approx. 10 g. The +/+ mice and one group of db/db mice were allowed food *ad lib*, while daily food allowance was restricted in another group of db/db mice. *Ad lib* db/db mice quickly became obese and developed all expected signs of diabetes. Obesity was prevented in the diet restricted db/db mice which helped normalize blood glucose and insulin levels and glucose intolerance. Obese db/db mice died with diabetes at 4-6 months of age; +/+ and lean db/db mice were examined for over 2 years. Comparisons were made on the weight of the spleen, thymus, pancreas, heart, kidneys, liver, testes, and inguinal fat pads; also compared were plasma and tissue neutral lipids and blood cell parameters. Diet restriction prevented some anatomical and physiological changes associated with the obese db/db mouse but had little effect on others.

EVIDENCE FOR THE RELEASE OF ENKEPHALINS AND OTHER ENDOGENOUS OPIATES BY MORPHINE. William L. Dewey, Department of Pharmacology, Medical College of Virginia, Richmond, VA 23298.

Peptides with opiate like activities have been isolated from the brain and pituitary glands of many animal species. We now present evidence that the narcotic analgesic, morphine causes a release of a substance(s) with opiate like effects into the cerebrospinal fluid. The purpose of these experiments was to determine if these released endogenous opiates were involved in the mechanism of action of morphine. A number of experiments in spinal mice clearly showed that information from the brain, which is considered to be the site of action of morphine, to the lower levels of the spinal cord is carried via CSF and is essential for inhibition of the tail-flick response. CSF taken from rabbits had opiate like activity in a number of in vitro and in vivo test systems. The opiate like activity of rabbit CSF was significantly increased 60 mins. after the injection of morphine. Radiotracer experiments demon-strated that the level of morphine in CSF was less than minimally active concentrations in these test systems ruling out the possibility that morphine was producing these effects. We found that morphine did not alter the opiate like activity of mouse brain extracts. These data indicate that the opiate like materials released from brain are very rapidly replaced. (Supported by USPHS grants DA-01647, DA-00326 and DA-00490).

POSTNATAL GROWTH RETARDATION AND BEHAVIORAL EFFECTS OF PHEN-CYCLIDINE ADMINISTRATION IN THE RAT. Stephen H. Dinwiddie* and R.L. Jordan. Department of Anatomy, Medical College of Virginia, Virginia Commonwealth University, Richmond, Virginia 23298.

Female Sprague-Dawley rats received 10 mg/kg injections (i.p.) of phencyclidine (PCP) once daily from day 6-15 of pregnancy and were allowed to deliver normally. At birth litters were culled to 8 pups and divided into 3 groups. Six litters were reared by PCP-treated dams, 3 litters by saline-injected control animals, and 3 litters by untreated dams. Control animals were fostered to PCP-treated dams, untreated dams or saline-treated dams in a similar fashion.

Pups were weighed and examined daily on three behavioral development tests: development of locomotion, development of climbing skills, and righting time.

Prenatal drug exposure had a greater effect than post-natal care. Pups exposed to PCP and reared by a PCP-treated dam gained significantly less weight during the neonatal peri-od than control pups and took significantly longer to develop locomotor and climbing skills. Animals exposed to PCP but reared by control dams also gained significantly less weight and were slower than controls on skill development, but the retardation was not as severe. Pups not exposed to PCP but reared by a PCP-treated dam showed a slight retardation in weight gain and skill acquisition.

(Supported by the Grants-In-Aid Program for Faculty of Virginia Commonwealth University and an A.D. Williams Summer Fellowship).

SITES FOR CHLORDECONE (KEPONE©) NEUROTOXICITY IN RAT BRAIN. David W. End*, Richard A. Carchman*, Richard Ameen*, Edward L. Carmines* and William L. Dewey. Dept. of Pharmacology, Med. Col. of Va., Richmond, VA 23298

The pesticide chlordecone (Kepone®) produces pronounced neurological effects in man and laboratory animals. We investigated the mechanism of these effects in rats. Concen-trations of chlordecone from 10^{-8} to 10^{-5}M produced a dose dependent inhibition of oxygen consumption and respiration dependent Ca^{++} sequestration in mitochondria isolated from rat brain. These effects of chlordecone were localized to an inhibition of the coupling reactions of oxidative phos-phorylation and were observed following in vivo administra-tions of tremorigenic (40 mg/kg, p.o.) doses of chlordecone. Chlordecone's inhibition of brain mitochondrial function led to elevations of cytosolic Ca^{++} in synaptosomes (pinched off nerve endings) which blocked the influx of extracellular Ca^{++} (the normal signal for neurosecretion) while triggering a marked release of the neurotransmitters dopamine, sero-tonin, and norepinephrine. Comparison of subcellular ^{14}C-chlordecone concentrations following in vivo administration to tissue concentrations achieved in vitro, revealed that a 5×10^{-6}M chlordecone concentration approximated a neuro-toxic tissue concentration of this neurotoxic substance. (Supported in part by EPA 804701010, DA-01647 and SM-1722901).

CROSS-CIRCULATION STUDIES ON THE SITE OF MORPHINE ANALGESIC ACTION IN THE BRAIN. <u>Tsu-Chinq Fu</u>*, Stephen P. Halenda* and William L. Dewey. Dept. of Pharmacology, Medical College of Virginia, Richmond, VA 23298.

The mechanism of action of morphine and other narcotic analgesics has not been fully elucidated. Previous work from this laboratory indicates that morphine causes the release of endogenous opiates which may be involved in its mechanism of analgesic activity. The purpose of these experiments was to determine the location of this release in the rat brain. Lightly pentobarbital-anesthetized rats were cross-cannulated, blood flowing from the donor body to the recipient head via the common carotid artery and returning via the external jugular vein. A good blood flow in the connected cannula was confirmed by pulsation and by saline infusion which was quickly washed down in the cannula. Antinociception was measured by the tail-flick test, control latencies being approximately 3 sec. 10 mg/kg morphine sulfate (MS) injected into the jugular cannula produced tail-flick latencies of greater than 10 sec. in the donor within 5 min., while no effect was seen in the recipient up to 60 min. after injection. 5 mg/kg MS injected into the carotid cannula towards the recipient head did not increase tail-flick latencies in either the recipient or the donor by 30 min. after injection. These results suggest that in rats the essential area for MS antinociception is not in structures above the midbrain. (Supported by DA-00326, DA-00490 and DA-01647).

NOVEL MESOIONIC PURINONE ANALOGS AS INHIBITORS OF CYCLIC-AMP PHOSPHODIESTERASE. <u>J. J. Gaines</u>*, R. A. Glennon* and M. E. Rogers*. Dept. of Pharmaceutical Chemistry, MCV/VCU, Richmond, Va.   23298

Various purinones, such as theophylline, inhibit cyclic 3]5'-adenosine monophosphate (cyclic-AMP) phosphodiesterase, an effect believed to be responsible, in part, for their clinical utility. Structural modification of such purinones has led to more potent and more selective inhibitors. Recently, we reported that mesoionic purinones are also active as inhibitors of cyclic-AMP phosphodiesterase. Mesoionic purinones constitute a virtually unknown class of heterocyclic compounds which warrant further investigation. We now wish to report the synthesis and evaluation of a series of benz-fused mesoionic xanthine analogs (<u>I</u>) which appear to be somewhat more active than their previously reported bicyclic counterparts.
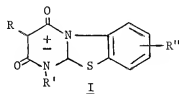
Supported in part by NIH grant HL-22566.

VASCULAR REACTIVITY IN CADMIUM-TREATED RATS. <u>J. L. Hart</u>. Biology Dept., George Mason Univ., Fairfax, Va. 22030

The responsiveness of helically-cut aortic strips from female Long-Evans hooded rats to epinephrine(EPI), KCl, and angiotensin II(ANG) was determined 1, 2, 3, and 6 months after beginning cadmium(Cd) treatment(5ppm in drinking water). No cadmium was added to the water of controls. Systolic blood pressures(tail cuff method under pentobarbital anesthesia) and weights were measured, and there were no differences between controls and Cd rats at any of the test periods. The mean initial weight($\pm$SE) of the 60 rats was 85.7 ± 9.3 g, and age was about 5 weeks. Complete dose-response curves were done on 5 or 6 aortic strips from each group at each test period. Both control and Cd rats showed similar age-related changes in responses during the 6 month study; however at all 4 test periods the maximum isometric tension development(g/cm^2) of the Cd strips to EPI was significantly less($p<.05$) than controls, with reductions ranging from 20 to 28%. Tension development of Cd strips to KCl and ANG were also consistently reduced, by about 20%, but the reductions were significant for KCl only at 2 and 6 months, and for ANG at 3 months. Previous studies involving acute Cd exposure found that Cd interfers with vascular smooth muscle contraction, an effect that was attributed to the ability of Cd to limit calcium ion movement and/or availability. The present studies demonstrate that chronic Cd ingestion also interfers with vascular contractility. (Supported by GMU grant #7010-2124.)

VASCULARIZATION OF THE CORPUS LUTEUM. <u>S. D. Gaede</u>*, and S. L. Quattropani*. Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298.

The vascularization of developing corpora lutea has been studied by light and electron microscopy in cycling adult and superovulated immature rats. Graafian follicles examined by light microscopy exhibit infoldings of the granulosa layer and adjacent thecal tissue. Adjacent to the basal lamina of the follicle, a layer of light-staining thecal cells is identified. Ultrastructurally, these cells exhibit a paucity of organelles. The granulosa cells of these follicles are in a pseudostratified configuration. Between them are numerous extravasated erythrocytes. In some large follicles, capillaries can be seen by light microscopy between the granulosa cells in the periphery of the follicle. While numerous mitotic figures have been identified in the thecal and granulosal tissue, these are generally associated with fibroblasts and granulosa cells.

Approximately one hour after ovulation, numerous capillaries can be seen in the peripheral region of the corpus luteum. The capillaries are thin walled with numerous large fenestrae. At these fenestrae, the basal lamina is continuous and blood platelets frequently appear to form plugs. Extravasated erythrocytes are seen between lutein cells and within the remains of the antral cavity.

ULTRASTRUCTURAL AND BIOCHEMICAL ALTERATIONS IN DESCEMET'S MEMBRANES FROM BUPHTHALMIC RABBITS. <u>T. M. Harris</u>. Dept. of Anatomy, *R. F. Diegelmann, Dept. of Surgery and L. B. Sheppard, Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298

Pure samples of Descemet's membranes (DM) were obtained from six buphthalmic rabbits (Jackson Laboratories, Bar Harbor, Me.) and 24 New Zealand white rabbits. Samples from three of the buphthalmic DM's were prepared for transmission electron microscopy and the remainder were pooled according to the source, hydrolyzed in 6N HCl, and prepared for analysis on a JEOL-5 AH Amino Acid Analyzer. Electron micrographs of DM from each of the three buphthalmic rabbits showed localized deposits of dense fibrillar material. The fibrils were approximately 52 nm in diameter and lacked any specific banding pattern. The amount of fibrillar material varied among the three animals, but in all cases, it was interspersed between zones of non-fibrillar, normal appearing DM. The amino acid analysis of the pooled buphthalmic membranes showed significantly increased levels of 3-OH proline compared to normal DM. These studies suggest that the deposition of the electron dense material coincides with the episodes of increased intraocular pressure that characterize advanced buphthalmia. The altered amino acid composition of the buphthalmic DM further suggests that the dense material represents a collagenous substance with a modified 3-OH proline content. (Aided by NIH Grant 1 RO1 EY 02991).

A FINE STRUCTURAL COMPARISON OF THE PINEAL GLAND OF THE GENETICALLY MICROPHTHALMIC GOLDEN HAMSTER WITH THE NORMAL. <u>M.E. Hill</u>*, C.G. Jackson*, J.T. Povlishock*, Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298

In order to assess the correlation between the pineal gland and the intact visual system, the present investigation was initiated to study pineal morphology in both microphthalmic and normal hamsters. To this end normal and genetically microphthalmic hamsters were processed for both routine light and electron microscopy. The morphological features of the control animals appeared unremarkable and both the pinealocytes and glial cells contained a complement of cellular organelles consistent with those previously described by others. In the genetically microphthalmic animals, however, conspicuous dilation of both the pinealocyte perinuclear cisterns and their smooth endoplasmic reticula was observed. Despite these alterations, all other pinealocytic organelles appeared unaltered. Although the dilated perinuclear cisterns and smooth endoplasmic reticula were the only observed cellular abnormalities, their occurrence was extremely consistent. The functional correlates of these cellular alterations remains to be assessed. However, an initial investigation on the role of these cellular perturbations in the genesis of gonadotropic interaction has been initiated. The results of these studies will be discussed.

COMPARISON OF SOMATOMEDIN-C AND A GROWTH HORMONE FRAGMENT WITH RESPECT TO RECEPTOR INTERACTION AND CERTAIN BIOACTIVITIES. J.R. Hubbard and J.P. Liberti*, Department of Biochemistry, Medical College of Virginia, Richmond, VA 23298 USA

Growth hormone(GH) is believed to increase cartilage growth and metabolism via secondary substances called somatomedins(SM). Thus while GH has no detectable effect on cartilage in vitro, GH-dependent SM directly stimulates chondrocyte growth, proliferation and synthesis of matrix. We now report that a growth promoting fragment of GH, A-II (bGH 96-133), has direct SM-like effects on cartilage and fibroblasts. Using a previously described SM assay, we found that A-II significantly increased proteoglycan sulfation in cultured human fibroblasts (WI-3B strain). This stimulation was log-dose dependent with maximal stimulation noted at 10^{-8} M. In the presence of hypo-GH serum both A-II and SM-C enhanced sulfation of embryonic chick cartilage in vitro. Maximal stimulation was noted with $5x10^{-11}$ M A-II and with 10^{-9} M SM-C. These substances had lower activity in the absence of this serum. A-II and SM-C also stimulated rat cartilage sulfation. In this system, serum was not required and maximal stimulation was noted at 10^{-7} M A-II or SM-C. Interestingly, A-II and SM-C competed for receptor(s) on both human placental membranes and chondrocytes. Thus, we are the first to show that a GH fragment (unlike the parent molecule) has SM-like bioactivities. The mechanism of GH-dependent SM generation is unknown. Our results invite speculation that certain SM(s) may be produced in vivo via proteolytic cleavage of GH. (Supported by NIH Grant AM-16457)

DEMONSTRATION OF A CARTILAGE PROTEASE ACTIVITY WHICH IS GROWTH HORMONE DEPENDENT. J.R. Hubbard, N.O. Owers* and J.P. Liberti*, Departments of Biochemistry and Anatomy, Medical College of Virginia, Richmond, Virginia 23298

Several in vivo effects of growth hormone(GH) on growth and metabolism of cartilage have been well documented. We now report the GH-dependent stimulation of a protease activity in cartilage. This activity was assessed by digestion of artificial gelatin membranes by slices of rat costal cartilage. The membranes were stained to visualize digested areas and photographed. The negatives were scanned at 540 nm to quantify the extent of digestion. The enzymatic nature of the reaction was inferred from our observations that digestion a) increased with longer incubation times, b) was pH-dependent and had an optimum of about 4.0, and c) was temperature-dependent, showing high activity at 37° and low activity at 100°. Cartilage protease activity of hypox (hx) rats given 4 daily injections of GH (total dose 1.5 ug-500 ug) showed a log-dose dependent increase over hx controls. 500 ug GH increased activity 3 to 4-fold. Specific activity appeared to be inversely proportional to rat age (or wt). This observation may relate to decreased GH-secretion and/or to decreased tissue responsiveness. This is the first demonstration of an acid protease activity in cartilage which is GH-dependent. This relationship may lend new insight regarding GH's action and mechanism. In addition, this system has potential use as a novel GH bioassay. (Supported in part by NIH Grant AM-16457)

FREEZE-FRACTURE STUDIES OF RAT UTERINE EPITHELIUM, M.J. Iwanik and W.P. Jollie, Dept. of Anatomy, Med. Coll. of Va., Va. Comm. Univ., Richmond, Va. 23298.

In order to clarify the effects of estrogen on the cell membranes of its target tissues, the freeze-fracture technique has been applied to the rat uterus during the estrous phase of the estrus cycle.

Uteri were fixed in 2.5% phosphate buffered glutaraldehyde, pH 7.4, cryoprotected in 30% buffered glycerol and frozen in Freon 12 cooled with liquid nitrogen. Specimens were fractured and replicated in a Polaron Freeze Etch Unit at a stage temperature of -120°C and a vacuum better than 10^{-6} Torr. Replicas were cleaned in Clorox for 24 hours.

Uterine epithelium was identified by the presence of microvilli. The plasma membrane protoplasmic face (PF) exhibits more intramembranous particles (IMP) than the extracellular face. Numerous subparticles were observed frequently in wave-like clusters. The occluding junctions are characteristic of "very tight" epithelia, measuring 0.70 μm in depth and consisting of 9-15 PF ridges. The ridges are more numerous and more compact in the apical third of the junction as compared to the basal two-thirds. Fracture faces of nuclear envelope membrane exhibit IMP, subparticles, and 8-10 nulcear pores per $μm^2$. Nuclear pores are circular in shape measuring 0.1 μm in diameter. Investigations are presently underway to determine if the membrane morphology is altered by estrogen withdrawal following ovariectomy.

BEHAVIOR OF MICE AFTER PRE- AND POSTNATAL EXPOSURE TO A PCB. Jan E. Jenkins* Biology Dept., George Mason Univ., Fairfax, VA 22030

Offspring of mice maintained on a diet containing 0, 5 or 100 ppm Aroclor 1254, a PCB, throughout gestation and lactation were maintained after weaning on the same diet to which their mothers were exposed. At 23 days of age half the offspring began 13 days of conditioned avoidance response (CAR) training. Number of correct responses per day, response time per trial and number of jumps during a 20-second intertrial interval were recorded. At 27 days of age half the offspring were observed in an open field for 30 minutes and number of squares traversed per 5-minute period was recorded.

PCB exposure had no effect on the ability of mice to learn the avoidance response. However, there were significant interactions between diet and day of CAR training for both response time and number of jumps, with decreases in response time over days occurring more rapidly in PCB exposed groups, and with decreases in number of jumps over days occurring more slowly in PCB exposed groups. There was also a significant interaction between diet and length of time in the open field, with decreases in number of squares traversed over time occurring more slowly in PCB exposed groups.

It is noteworthy that these behavioral effects occurred at a chronic, low dose of PCBs which was insufficient to cause morphological symptoms.

A Study Of The Inhibitory Effects Of Copper In Feline Urinary Obstruction. L.K. Keating*, H.Q. Tucker*, and R. T. Friedman, Tucker Animal Hospital, Orange, Va. 22960 and Dept. of Biology, Mary Washington College, Fredericksburg, Va. 22401.

Placement of a copper coil into the bladder of 21 male cats with urinary obstruction over a 5 year period resulted in alleviating the symptoms and preventing recurrence of the obstruction. Experiments carried out on copper balance in two groups of cats, coil implant(C_2) and no coil(N_2), support the hypothesis that with the coil in place excess copper is excreted in the urine in amounts that approximate that released by the coil. Additional studies were carried out on four normal cats, two with coil and stone implants (CS_2) and two with stone implants(S_2). After six weeks, in the (S_2) cats, the stone or sediment was present and gross pathology of the bladder was observed in one case, while on the (CS_2) cats, the stone had dissolved, no pathological changes were seen and urinary copper values were elevated suggesting that copper acts not only to inhibit stone formation but to dissolve existing material.

ISOLATION OF A MACROPHAGE CHEMOKINETIC FACTOR FROM CULTURE MEDIA CONDITIONED BY NEOPLASTIC CELLS. R. D. Lane*, and M. J. Snodgrass. Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298.

Cultured neoplastic cells have been shown to release a 15,000 dalton molecule that is a chemotactic (direction) for activated macrophages. Time lapse cinematography indicated that media conditioned by neoplastic cells was chemokinetic (rate) for activated macrophages. One purpose of our investigation was to develop an assay for readily quantitating this chemokinetic effect. A modified macrophage inhibition type of assay was found to be suitable for this purpose.

Peritoneal exudate cells from C57BL/6 mice injected ip 7 days previously with Corynebacterium parvum were used as our source of activated macrophages. The assay involved measuring the distance these cells traveled down the length of capillary tubes immersed in various conditioned culture media. Our results showed the distance traveled by activated macrophages in Lewis lung carcinoma conditioned media was 2.5X greater than the distance traveled by these cells in mouse embryo fibroblast conditioned media. To determine the molecular size of chemokinetic factor the Lewis lung conditioned media was fractionated on a Shephadex G-100 column. Each fraction was then tested for chemokinetic activity with our assay. The chemokinetic factor was found to be in excess of 10^7 daltons.

DIFFERENTIAL SENSITIVITY OF MACROPHAGES TO TUMOR PROMOTERS AND EPIDERMAL GROWTH FACTOR. D. L. Laskin*, F. K. Kessler*, and R. A. Carchman*. Department of Pharmacology, Med. Col. of Va., Richmond, Va., 23298

The effects of 12-O-tetradecanoyl-phorbol-13-acetate (TPA) on phagocytosis of opsonized (OPS) and unopsonized (UNOP) chromated sheep red blood cells (sRBC) by mouse peritoneal macrophages (MΦ) recruited either by thioglycollate (TG) or the pyran copolymer, methyl vinyl ether (MVE), and a transformed cell line, P388D1 were studied. TPA, in the range of 10^{-9} to 10^{-7} M, produced a dose related stimulation (180%) of phagocytosis of both OPS and UNOP sRBC in P388D1 cells, and of UNOP sRBC in TG and MVE cells (150%). Although low concentrations of TPA (10^{-9} M) produced a 130% stimulation of phagocytosis of OPS sRBC in the peritoneal MΦ, higher concentrations (10^{-7} M) produced a 50% inhibition. This inhibition was due to a direct effect on the membrane and/or receptor properties of the cells, as evidenced in scanning electron micrographs, and not to a loss in cell number or viability. With a series of macrocyclic diterpenes, we found a correlation between their ability to modulate phagocytosis and their potencies as tumor promoters. Epidermal Growth Factor (EGF) which shares many effects with TPA, produced a dose related stimulation of phagocytosis of UNOP sRBC in all three cell types (160%) and of OPS sRBC in P388D1 cells (180%). Unlike TPA, EGF had no effect on TG or MVE cells. These findings provide additional evidence that tumor promoters exert highly pleiotropic effects on cell surface functions.

AFFERENT CONNECTIONS OF THE CLARE-BISHOP (CB) AREA IN THE CAT BRAIN. A.J. McGrath, Jr., G.R. Leichnetz*, and J. Astruc*. Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23298

The Clare-Bishop (CB) area bears the names of the investigators who first (1954) recognized a region located primarily on the lateral aspect of the middle suprasylvian gyrus of the cat cortex and which electrophysiologically appeared to be involved in visual functions. More recent investigations (Kennedy and Magnin, 1977; Spear and Baumann, 1979) of the CB area have supported its role in visual and/or oculomotor functions. Anatomical studies were initiated to ascertain the afferent connections of this cortical area. Results based on HRP studies (BDHC and TMB, Mesulam) indicate that CB receives corticocortical and subcortical projections. Most notably, ipsilateral areas 17, 18, and 19 as well as the contralateral CB area project to CB. Prominent subcortical projection sites include the basal telencephalon (mainly the claustrum) and the diencephalon (the ventral anterior, intralaminar nuclei, LP-Pulvinar complex, posterior nucleus and the dorsal lateral geniculate nucleus). The data from this study appear to provide an anatomical substratum for a possible role of the Clare-Bishop area in visual and/or oculomotor functions.

MAGNESIUM AS A MODULATOR OF CONTRACTILITY IN VASCULAR SMOOTH MUSCLE. R.S. Moreland*, G.D. Ford*, Dept. of Physiology, Med. Col. of Va., Richmond, Va. 23298.

The regulation of vascular smooth muscle (VSM) contractility has been of interest due to its role in blood pressure and hypertension. Many studies have reported changes in VSM response to physiological agonist under varying ionic conditions. One of the most actively studied constituents of these ionic conditions has been extracellular magnesium (Mg^{2+}). Assuming changes in extracellular Mg^{2+} may reflect changes in intracellular Mg^{2+}, this study was carried out to determine if there was a Mg^{2+} effect on the intracellular contractile apparatus, actomyosin (AM). Since VSM contraction is the product of a Ca^{2+}-activated AM ATPase and believed to be regulated thru a calcium-sensitive myosin light chain phosphorylation system, the influence of free Mg^{2+} levels on Ca^{2+}-activated AM ATPase activity, sol-gel transformation of AM, total phosphorylation of AM, and phosphorylation of the myosin light chain kinase were monitered. The results of these experiments showed a definite Mg^{2+} dependence of the Ca^{2+}-activated AM ATPase and total phosphorylation with optimums at 5mM Mg^{2+}. The rate of and extent of sol-gel transformation as well as rate of total phosphorylation were augmented by increasing Mg^{2+} levels. However phosphorylation of the myosin light chain did not correlate with changes in Mg^{2+} levels. This data strongly suggests an integral role of Mg^{2+} in the regulation of VSM contractility entailing more than just the myosin light chain phosphorylation system.

A MORPHOLOGICAL STUDY OF ARACHNOID VILLI IN THE BABOON. Levine, J.E.*, Povlishock, J.T.*, Sullivan, H.G.*, Becker, D.P.* Depts. of Anatomy and Neurosurgery, Med. Coll. of Va., Richmond, VA 23298

Defective cerebrospinal fluid (CSF) absorption remains an important clinical problem. Although most investigators agree that arachnoid villi are the major location of the absorptive process, the mechanism remains elusive.

To better examine this phenomenon we have initiated a pilot study in a physiologically monitored and controlled baboon model. In this animal, factors influencing CSF absorption such as the intracranial and sagittal sinus pressures are monitored and held within strict limits. Concomitant with this physiological control, the animals are perfused transcardially with aldehydes and processed for scanning (SEM) and transmission (TEM) electron microscopy. Via SEM the villi appear composed of continuous endothelia; their surface morphology demonstrating an irregular and invaginated contour reminiscent of vacuolization. TEM confirms and supplements the SEM by demonstrating conspicuous endothelial vacuoles; additionally micropinocytotic vesicles are seen. It is anticipated that future studies using tracers and modification of pressure gradients may elucidate the role these arachnoid endothelial features serve in CSF absorption.

AN ULTRASTRUCTURAL STUDY OF DEVELOPING MOUSE FETAL LIVER. E.S. Medlock*, J.L. Haar*, Dept. of Anatomy, Med. Col. of Va., Health Sciences Division, Virginia Commonwealth University, Richmond, Va. 23298

Mouse fetal liver morphology of 10-, 11-, 12-, 14- and 17-day old fetuses was studied utilizing light, transmission and scanning electron microscopy. Localization of endogenous peroxidase was studied using light and transmission electron microscopy. The vasculature of the hepatic primordium was represented by large vessels ($> 20 \mu$) with a continuous endothelial lining and small vessels (4-20μ) with a discontinuous endothelial lining. Precursors of hepatic parenchymal and hemopoietic cells (including myelopoietic, thrombopoietic and erythropoietic cells) composed the bulk of the liver substance. Parenchymal precursor cells were identified by the accumulation of lipid, glycogen and membrane bound dense core vesicles. Scanning microscopy has shown a correlated increase in microvillous projections on the lateral cell margins of parenchymal precursors with an increase in gestational age. Myelopoietic precursors exhibited a positive peroxidase reaction in the nuclear envelope, rough endoplasmic reticulum and within membrane bound vesicles. Erythropoietic precursors exhibited a positive peroxidase activity in the form of a diffuse cytoplasmic precipitate. On the basis of the above cytological evidence, a morphological comparison of the above age groups was performed analysing structural changes within the mouse fetal liver.

INTRACELLULAR AND FIELD POTENTIAL RECORDINGS FROM THE RAT OLFACTORY CORTEX. J.W. Nemitz* and S.J. Goldberg*. Department of Anatomy, Med. Coll. Va. - VCU, Richmond, VA. 23298.

Bipolar electrical stimulation of either the lateral olfactory tract (LOT) or olfactory bulb (OB) in urethane anesthetized male rats elicited characteristic field potential and single unit responses in the ipsilateral olfactory cortex. An air-dilution olfactometer was also used to deliver 250 msec. pulses of odor to the rats. A tracheal tube and a tube ascending to the choana were inserted. Controlled suction applied to the ascending tube produced an artificial sniff during odor presentations. Recordings were made with beveled, potassium citrate (1.6M) filled micropipettes.

9 cells were recorded in response to LOT stimulation and showed an average latency of 9.1 msec. to spike initiation. 2 of the recordings were intracellular and had latencies of 1 and 3 msec. to initiation of the EPSP. 22 cells were recorded in response to OB stimulation and showed an average latency of 12.5 msec. to spike initiation. 5 of the recordings were intracellular and had latencies of 1-5 msec. to initiation of the EPSP. 22 of the total 31 cells were subjected to odor stimulation with 1-carvone (1 part/100). 11 cells were excited, 8 showed no response and 3 cells' responses were equivocal upon odor presentation. Inhibitory responses were never observed extracellularly or intracellularly.

These preliminary results indicate that 50% of olfactory cortex neurons respond with excitation to 1-carvone and that neuronal inhibition is not apparent in the cells studied.

THE ANATOMICAL DISTRIBUTION OF NERVE FIBER DEGENERATION FOLLOWING SINGLE AND MULTIPLE CEREBRAL CONCUSSIONS IN RATS. L. Claire Parsons, R.N., Ph.D., University of Virginia, School of Nursing, McLeod Hall, Charlottesville, VA 22903
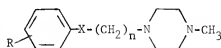
Laboratory rats between 250 and 350 g and following concussion disc implantation were subjected to single and multiple experimental cerebral concussions (ECC) administered through use of a spring coil concussion gun. The force of the blows ranged between 26 and 40 lbs/PSI. Criteria for severity of concussion were established utilizing length of seizure, return of corneal reflex and return of motor reflexes. The Fink-Heimer II silver staining method was used to identify nerve fiber and nerve terminal degeneration. A Nissl stain was used to identify cell soma changes and brain stem nuclei. Nerve fibers coursing through coup and contracoup regions of the brain appeared to receive the greatest injury. These regions showed both nerve fiber and nerve terminal degeneration and include the optic nerve, chiasm, tract, transpeduncular nucleus, superior colliculus and lateral geniculate. Cerebrocortical, as well as corpus collosal fibers, showed degeneration but to a lesser extent. Contrary to earlier reports by other investigators, no consistent nerve fiber or cell soma changes were observed to occur in the brain stem reticular formation.

ARALKYLPIPERAZINES AS POTENTIAL DOPAMINE RECEPTOR ANTACONISTS. J. Salley Jr.* and R. A. Clennon.* Dept. of Pharmaceutical Chemistry, MCV/VCU, Richmond, Va. 23298

Involvement of dopaminergic systems has been implicated in the mechanism of action of neuroleptic agents. Various phenothiazines, thioxanthenes and butyrophenones display a high degree of binding to the postsynaptic receptors of various dopamine (DA) receptor preparations and their ability to inhibit haloperidol binding correlates closely with their clinical potencies. In view of the structural differences among these antagonists, the question arises as to whether activty might reside in a related molecular subfragment. Several aralkylpiperazines, which might be viewed as representative subfragments, were synthesized and evaluated for antagonism employing a rabbit artery DA receptor preparation. Although several of the new compounds act as antagonists, none are as potent as the established neuroleptic agents.

THE EFFECTS OF THE DIABETIC STATE ON MORPHINE ACTION IN MICE. Glenn Stuart Simon*, and William L. Dewey. Dept of Pharmacology, Med. Col. of Va., Richmond, VA 23298

Streptozotocin (STZ)-induced diabetes causes a significantly decreased antinociceptive potency of morphine, phenazocine and levorphanol as quantitated the mouse tail-flick test. This effect is reversed by insulin. The potency of meperidine, methadone and propoxyphene were not altered. Other alterations that cause hyperglycemia or hypoglycemia also cause a significantly decreased or increased (respectively) potency of morphine, phenazocine and levorphanol, but not meperidine, methadone or propoxyphene. The effect of diabetes on morphine potency was confirmed in STZ-diabetic rats and in a strain of genetically diabetic mice. The duration of action of morphine is not altered by STZ-diabetic in the mouse. Levels of ^3H are not altered in the brains of STZ-diabetic mice treated with ^3H-morphine when compared with controls. Changes in brain glucose levels are accompanied by similar changes in brain-glucose levels and inversely altered plasma insulin levels. These data indicate that diabetes or other conditions that cause altered blood glucose levels can selectively alter the potency of certain narcotics, but not all. An effect at the opiate receptor is not indicated, nor is altered absorption, metabolism, excretion or transport into the brain. (Supported in part by NIH Grants # DA-01647, DA-00490 and GM-07111).

COMPARATIVE ULTRASTRUCTURE OF THE NUTRIA AND GROUND SQUIRREL PINEAL GLANDS. R.L. Salisbury*, R.J. Krieg*, J.T. Povlishock* and H.R. Seibel. Dept. of Anatomy, Med. Col. of Va., Richmond, Virginia 23298.

The pineal glands of the 13-lined ground squirrel (Citellus tridecemlineatus) and nutria (Myocastor coypus) were examined by electron microscopy. Both glands contained numerous parenchymal cells around which glial, vascular and neural elements ramify. The parenchymal cells displayed an euchromatic nucleus and a distinct nucleolus. Parenchymal cytoplasmic features common to both animals were mitochondria, Golgi complexes, short profiles of rough and smooth endoplasmic reticulum and occasional dense-cored vesicles (DCV). Lipid droplets, microtubules, multivesicular bodies as well as an electron dense cytosol and few glycogen particles were characteristic of the ground squirrel parenchymal cells. In both species processes of parenchymal origin terminated in bulbous endings. Such endings possessed clear vesicles, mitochondria, and occassional DCV. The ground squirrel vasculature was surrounded by an expanded perivascular space (PVS) in which axons, parenchymal cell terminals and collagen fibers coursed. These vascular elements manifested a fenestrated endothelial lining. The nutria vascular endothelia appeared continuous and glial processes invested the perivascular basal lamina. These findings suggest that the ultrastructural characteristics of the ground squirrel pineal are comparable to those of endocrine tissues, while those of the nutria are reminiscent of brain tissue.

RADIOSENSITIVITY OF MICROVASCULAR GROWTH. M.M. Sholley*, J.L. Montour*, and J.D. Wilson*. Depts. of Anatomy and Radiology, Med. Col. of Va., Richmond, Va. 23298.

The radiosensitivity of microvascular growth was studied using a corneal neovascularization model. The left eyes of rats were irradiated, using single doses (500,1000,2000,4000, and 8000 rads) of 45 kVp x-rays. Within 10 minutes after exposure, both corneas were centrally cauterized with silver nitrate. Cauterization elicits a centripetal growth of new vessels from the limbus into the previously avascular cornea. The vessels were perfused with colloidal carbon and the vascular length was measured in corneas fixed at 4 and 7 days. In some cases, ^3H-thymidine (^3H-Tdr) incorporation at 2 and 4 days was measured on autoradiographs. Dose-response curves based on length appeared to have two components: a sensitive component existed up to 2000 rads, the growth (% of control) having dropped to $68.6 \pm 2.9\%$ and to $37.2 \pm 1.5\%$ at 4 and 7 days, respectively; whereas, an insensitive component existed up to 8000 rads, where $53.9 \pm 1.0\%$ and $29.1 \pm 2.0\%$ remained at the same times. The absolute vascular lengths (mm) at both 4 and 7 days were similar at doses from 2000 to 8000 rads. Endothelial ^3H-Tdr labeling at 2 days after 2000 rads was reduced to 6.7% of control. The results suggest that cellular proliferation falls off sharply between 1000 and 2000 rads, while a second, more radioresistant, mechanism permits the growth persisting at higher doses. We propose that the radioresistant growth results from migration and redistribution of preexisting endothelial cells from the limbal vessels. (Aided by ACS grant IN-105-C).

A NOVEL NON-CONTACT METHOD OF MEASURING THREE-DIMENSIONAL SURFACES. Milton Skolaut, Ernest E. Burcher,* and W. Lane Kelly IV.* NASA Langley Research Center, Hampton, Va. 23665

A breadboard optical profilometer has been developed to measure small, three-dimensional surfaces and to find certain specially marked points on these surfaces. The data are presented to the researcher both as a printed contour map and on a cassette tape for input to a larger computer. Although the current breadboard model was designed for a 1.4 cm depth and a 5.5 x 5.5 cm width and length, reasonable increases in depth and large increases in width and length are possible by redesigning the optics and transport system. The breadboard system has been delivered to a dental researcher for a year's field trial of measuring cleft palate casts.

CAN THE NALOXONE RESISTANT COMPONENT OF STRESS-INDUCED ANALGESIA BE ANTAGONIZED. Anne Snow*, Susan M. Tucker*, Stephen P. Halenda* and William L. Dewey. Dept. of Pharmacology, Med. Col. of Va., Richmond, VA 23298

Stress-induced analgesia may be produced by a variety of stressors, including inescapable foot shock, swim stress and immobilization. Reported as possible mediators of this analgesic response are β-endorphin, leucine-enkephalin and methionine-enkephalin. We looked at this phenomenon in terms of the role which endogenous opioids and neurotransmitters have in the genesis of this analgesic response. Rats were exposed to inescapable intermittent foot shock. This stressor produced a 2-3 fold increase in tail-flick latencies. The analgesic response was only partially antagonized by naloxone. To examine the role of neurotransmitter systems in this resistant component, receptor antagonists such as haloperidol, atropine and BC105 were used. Diazepam and dexamethasone were also used in an effort to prevent stressor-induced analgesia. Neither the receptor antagonists, dexamethasone, nor diazepam were able to antagonize the remaining analgesia. However, atropine and BC105 did attenuate the analgesic response. In conclusion, the phenomenon of stressor-induced analgesia appears to involve two mechanisms: one which is mediated by endogenous opioid systems and is naloxone reversible; and another unidentifiable component which is extremely resistant to antagonism and may involve cholinergic and serotonergic pathways. (Supported by USPHS Grants DA-01647, DA-00326 and DA-07027).

FACTORS INFLUENCING ATHLETIC AMENORRHEA. K.A. Sweeney* and D.K. Wakat,* Sch. of Nursing, U.Va., Charlottesville, Va.

Forty-one of 77 college female cross-country runners were subjects in a study to determine factors related to athletic amenorrhea. Athletes were classified as either normal cycling N=49% or oligo/amenorrheic O/A=51%. Comparisons were made of training history, menstrual history, anthropometry and hormone levels. No significant differences between the groups were observed in the following: age(N=19.6+0.3 vs O/A=19.5+0.3 yrs), weight (119.9+3.7 vs 118.1+2.5 lbs), skinfold thickness sum (48.8+2.3 vs 45.8+2.6 mm), % body fat (17.13+0.5 vs 16.9+0.44), age at which training began (14.03 +0.6 vs 13.81+0.5), years in training(4.98+.5 vs 5.14+.4), miles run/week(45.7+3.7 vs 52.3+3) and HCT(40.8+.5 vs 40.0 +.8%). Both groups had elevated levels of HGH(18.6+6.5 vs 14.8+3.5mg/ml), PLR(34.3+2.7 vs 32.9+2.7 mg/ml) but mean values were not significant. A significant difference between the two groups, however, was the onset of menarche (12.9+.3 vs 14.2+.5 yrs, p .05). More O/As began training at or prior to menarche (45% vs 67%). In addition only 3 of the 18 women runners who were O/As were below the minimum weight for height using Frisch's nomogram (Science 185: 949, 1974). A relationship seems to exist between the onset of training and the onset of menarche. This lack of menses found mainly in those who experienced menarche at a significantly later time cannot be explained by the Frisch hypothesis.

SYNTHESIS AND PHARMACOLOGY OF SOME POTENTIALLY NON-ABUSIVE NARCOTIC ANALGESICS. M. K. Waddle* and M. E. Rogers*. Dept. of Pharmaceutical Chemistry, Med. Col. of Va., Richmond, Va. 23298.

Ketobemidone, a 4-phenylpiperidine analgesic clinically used in Europe, is equivalent to morphine as an analgesic but is highly addicting. Recent studies have shown that changing the nitrogen methyl to pentyl retains analgesic potency and greatly lessens the physical dependence capacity. We wish to report the synthesis and pharmacology of a series of ketobemidone analogs (I) with varying nitrogen substituents. These compounds were prepared in order to delineate those structural features necessary for analgesic activity and those associated with addiction liability. These compounds have been examined in mice for antinociceptive properties, in rat brain homogenates for receptor affinity, and in morphine dependent monkeys for physical dependence capacity. Several of the newly synthesized compounds appear to merit further investigation as strong non-abusive narcotic analgesics.

(I)
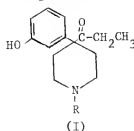
THE EFFECTS OF INTRAVENOUS INJECTION OF NALTREXONE ON PITUITARY LH RELEASE IN THE OVARIECTOMIZED RAT. Alan R. Swajkoski* and J.H. Johnson, Dept. of Anatomy, Med. Coll. of Virginia, Richmond, Va. 23298.

Morphine and methadone inhibit pituitary LH release and spontaneous ovulation in the rat (Maughan et al. 1978). Potent narcotic antagonists such as naltrexone selectively inhibit opiate effects on both pituitary LH release and spontaneous ovulation. This study investigated the effects of intravenous injection of naltrexone, which binds to the opiate receptor, on tonic release of pituitary LH in the ovariectomized rat. Fourteen long-term ovariectomized rats (Sprague-Dawley) were anesthetized with Brevital, and cannulae were inserted into the right external jugular vein to approach the right atrium. Seven rats received .1 ml saline i.v. (0.9% heparinized 10 units/ml) while the remaining seven were injected with naltrexone (1 mg in .1 ml) through indwelling cannulae. Whole blood samples (100 μl in duplicate) were collected for 3 hours at 10 minute intervals from each rat, and blood was assayed for LH by double antibody radioimmunoassay. Saline and naltrexone failed to alter pulsatile rhythms of LH release in all 14 animals. Furthermore, mean levels of LH were not significantly different in the two groups as determined by Student's t test. These results indicate that this dose of naltrexone does not influence LH release, and therefore could be used in attempts to antagonize the effects of narcotics on the release of gonadotropins. (Supported by NIH Grant HD 12165-01).

EFFECTS OF 11-HYDROXY-Δ^9-TETRAHYDROCANNABINOL ON BRAIN CHOLINERGIC SYSTEMS. Hem L. Tripathi*, Sandra K. Welch*, Ramona J. Winckler* and William L. Dewey. Dept. of Pharmacology, Med. Col. of Va., Richmond, VA 23298

We have studied the effects of 11-hydroxy-Δ^9-tetrahydrocannabinol (11-OH-Δ^9-THC) an active metabolite of Δ^9-THC the predominant constituent of marihuana, on levels and turnover rate of acetylcholine (ACh) and levels of choline (Ch) in various mouse brain regions (medulla-pons, corpus striatum, midbrain, hippocampus and cortex). Doses of 11-OH-Δ^9-THC of 1, 10 and 30 mg/kg were administered i.p. and after 20 min. 6.4 mCi (80 nmoles/kg) of ^{3}H-Ch was infused via the tail vein. Groups of 6 to 12 mice were sacrificed at either 2 or 3 min. by microwave irradiation of the head. ACh turnover rate was determined by the biosynthesis ratio method (Schuberth et al., J. Neurochem. 16:695, 1969). 11-OH-Δ^9-THC did not effect the level of ACh in any brain region but showed a dose related decrease in turnover rate of ACh in the hippocampus region. The difference was significant only at 30 mg/kg. Ch levels showed an increase in all the brain regions but a significant increase was only seen in medulla-pons, midbrain and cortex regions. Although there are a number of similarities among the effects of various cannabinoids on central cholinergic mechanisms significant differences exist which suggest that the behavioral effects of cannabinoids are not related to their effects on this neurotransmitter. (Supported by USPHS grants DA-00326, DA-00490 and DA-07027).

FOREBRAIN NEURAL ACTIVITY AND ELECTRICAL STIMULATION OF THE MIDBRAIN RAPHE. K.W. Waller and J.H. Johnson, Dept. of Anatomy, Med. Col. of Va., Richmond, VA. 23298

The present preliminary studies show effects of electrical stimulation of the midbrain on neural activity of forebrain areas known to influence gonadotropin release. Midbrain regions in 8 long-term ovariectomized rats were stimulated with 1 mA 50 μsec biphasic constant current pulse pairs at 10Hz, 30 sec off/on for one hour through chronically-implanted electrodes. Multiple unit activity (MUA) was recorded from the preoptic area (POA) and dorsal hippocampus (DHPC) one hour before, during, and one hour after stimulation. Blood samples obtained at 10-minute intervals via a jugular catheter were assayed for luteinizing hormone (LH). A decrease in blood LH appeared to accompany a rise in the minima reached by integrated preoptic MUA in both control and stimulation periods (n=4). LH levels decreased during stimulation of dorsal raphe. DHPC activity increased during DR stimulation and remained elevated 30-40 minutes beyond the stimulus. Stimulation of lateral periaqueductal gray regions (n=3) was followed by increases in DHPC or POA activity for the duration of the recording, suggesting a more generalized neural activation. These preliminary data tentatively suggest inverse relationships between preoptic or hippocampal MUA and LH release in the ovariectomized rat.

COMPARISON OF THE ANTINEOPLASTIC ACTIVITY AND TOXICITIES OF THE SODIUM AND CALCIUM SALTS OF MALEIC VINYL ETHER COPOLYMER (MVE). K.L. White, Jr.*, P.C. Klykken*, and A.E. Munson. Dept.of Pharmacology, Med.Col. of VA/VCU, Richmond, VA 23298
    Maleic Vinyl Ether copolymer (MVE) has been shown to have both antineoplastic and antiviral activities. These activities are related to the molecular weight (MW) of the copolymer fraction with MVE-4 MW 32,000 being more efficacious than MVE-2 MW 15,500. Acute toxicity, characterized by immediate onset of convulsions, respiratory depression and cardiovascular collapse, results in death within 3 min. of intravenous injection. The Na salt and Ca salt (20% neutralized) of MVE-2 and MVE-4 were compared in Balb/c mice for acute toxicity, sensitization to lipopolysaccaride (LPS), and antineoplastic activity. I.V. administration of the Ca salt of MVE-2 produced a LD_{50} of 213 mg/kg while the Na salt resulted in a LD_{50} of 60 mg/kg. Similarly, the Ca salt of MVE-4 had a LD_{50} of 199 mg/kg compared to LD_{50} of 45 mg/kg for the Na salt. While the Na and Ca salts of MVE-2 equally increased susceptibility of mice to the lethal effects of LPS, the Ca salt of MVE-4 decreased sensitivity to endotoxin by 3-fold. In mice bearing Madison 109 lung carcinoma, weekly I.V.administration of 25 mg/kg of the Ca salt of MVE-2 decreased growth rate of the primary tumor by 54%. However the Na salt of MVE-4 was more efficacious than the Ca salt, producing a 72% decrease in primary tumor growth. Mean survival time (MST) followed the same pattern. These studies indicate that the Ca salt of MVE-2 markedly decreases the acute toxicity while significantly increasing the antineoplastic activity.

INHIBITORS OF RAT LIVER HMG—CoA REDUCTASE AS POTENTIAL HYPO-CHOLESTEROLEMIC AGENTS. Yeong-Maw Yeh*, M. R. Boots, Dept. of Pharmaceutical Chemistry, Med. Col. of Va., VCU, Richmond, VA 23298, and S. G. Boots*, Dept. of Chemistry, Stanford Univ., Stanford, CA
    HMG-CoA reductase mediates the rate-limiting step of mammalian cholesterol biosynthesis. Inhibition of this reaction provides the most efficient inhibition of the entire biosynthetic pathway and thereby hopefully causes a reduction of serum cholesterol levels. Our previous work indicated that the presence of a 3-hydroxylgroup in arylalkyl hydrogen glutarates increases inhibitory activity. In an attempt to obtain additional information concerning the molecular requirements for inhibition of HMG-CoA reductase a series of 1-(4-biphenylyl)-n-pentyl hydrogen 3-hydroxy-3-alkyl and 3-alkyl glutarates were prepared and evaluated. The 3-alkyl series was specifically designed to determine if there was a hydrophobic binding site on the enzyme where the 3-alkyl group of the glutaric acid moiety could bind. The 3-hydroxy-3-alkyl series was investigated to determine if binding to the hydrogen bonding site via the hydroxy group and the hydrophobic site via the 3-alkyl group on the enzyme could occur simultaneously. The synthesis and biological evaluation of these inhibitors will be discussed.

5p-SYNDROME:A SURVEY OF 62 NON-INSTITUTIONALIZED PATIENTS. L.E.Wilkins; J.A.Brown,Ph.D.* Dept. of Human Genetics,Med. Col. of Va., Richmond, Va. 23298
    The Cri du Chat syndrome(5p-) is a rare chromosome abnormality in man with an incidence of 1 in 50,000 live births. Data from previous studies of institutionalized Cri du Chat individuals have resulted in a clinical picture with a grim prognosis. This study has demonstrated that the Cri du Chat child can be raised at home and with special schooling can attain the skills of a normal 6 to 7 year old child. We present data on 62 non-institutionalized Cri du Chat patients which were obtained from parental questionnaire response and medical records. The subjects ranged from 2 months to 26 years of age and included 1.8 times more females than males.
    A wide range of variability was evident in the child's condition at birth, the severity of the physical malformation and the level of mental development. While signficant neonatal complications suggestive of Cri du Chat were present in 24% of the subjects,41% were considered normal at birth. Social quotients ranged from 6 to 85. The variability in the developmental characteristics of these children was examined with respect to the child's condition at birth, the presence of chronic illness and the age at starting school. The impact on both the child and parents of early infant stimulation and preschool programs will be presented in detail. Frequently noted health problems and medical complications encountered when raising the Cri du Chat child at home will be discussed.

Microbiology

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INFLUENCE OF CHRONIC AFLATOXICOSIS ON VIRUS INFECTION IN THE MOUSE. G.R. Bryson*, P.H. Hartig*, G.C. Llewellyn and S.R. Webb. Biology Department, Virginia Commonwealth Univ., Richmond, Virginia 23284
      Encephalopathy and visceral fatty degeneration (EVFD) diseases occur with rapid onset and cause high mortality in affected youths. Though their etiology has not been established, increased incidence of these diseases has followed viral epidemics in societies subject to high environmental toxin levels. C57BL/6 male mice, 5 weeks old, were segregated into two groups: one group was fed Lab Chow, the other was fed Chow supplemented with 10.7 ppm mixed aflatoxin throughout the experiment. After six weeks, half of the mice in each group was infected by i.p. injection with 300 PFU of Coxsackievirus B4 (CUB4) and examined at 4 and 21 days after infection. At the time of infection toxin and chow animals were the same weight and had the same levels of plasma SGOT, BUN, insulin, and blood glucose. However, toxin caused vacuolization of hepatocytes and mitochondrial swelling. Virus replicated to the same high titers in liver, pancreas and kidney of both groups. SGOT and BUN were similarly elevated during the acute stage and surviving mice were relatively normal by 21 days post infection. C57BL/6 mice were extremely resistant to aflatoxcosis and thus viral potentiation was negligible in this virus-host system.

ENZYME-LINKED IMMUNOSORBENT ASSAY FOR CYTOMEGALOVIRUS DE-TECTION. R.S. Fowler, M.R. Escobar, N.J. Reedy and C.W. Moncure. Med. Coll. of Va.-Va. Comm. Univ., Richmond, Va.
      The low recovery of human cytomegalovirus (CMV) from clinical specimens as well as the time-consuming, costly and tedious procedure for its isolation and identification led us to search for a better method. An enzyme-linked immunosorbent assay (ELISA) consisting of a double anti-body sandwich technique using horseradish peroxidase as an enzyme maker was developed for the detection of CMV anti-gen. The optimum incubation times and temperatures for the various steps in the assay which produced the maximum sensitivity for the detection of antigen were determined. The optimum concentration of solid phase antibody and of conjugate were also defined. A confirmatory test using blocking antibody was performed to ascertain the specifi-city of the assay. CMV antigen from two sources was test-ed. Other members of the herpesvirus group were used as controls to demonstrate the specificity of this procedure.

CHARACTERIZATION OF NORMAL AND TUMOR-BEARING MOUSE SOLUBLE MACROPHAGE REGULATORS OF T CELL BLASTOGENESIS. K. N. Connolly,* K. D. Elgert, and J. M. Conroy.* Dept. of Bi-ology, Va. Polytech. Inst. and State Univ., Blacksburg, Va. 24061
      Macrophage (Mϕ) regulation of mixed lymphocyte reaction (MLR) reactivity in murine T lymphocytes appears to be a non-contact, concentration dependent phenomenon. That is supernatants from high concentrations of peritoneal Mϕ inhibited while low doses enhanced MLR activity. Superna-tants contained a heat stable inhibitor factor; nonthymi-dine in nature as shown by dialysis and competitive inhi-bition experiments. Treatment of Mϕ with indomethacin did not abrogate release of inhibitor factor, thus indicating its non-prostaglandin composition. Heat labile enhancing factor, obtained from Mϕ sonicates as well as supernatants, could be distinguished from lymphocyte activating factor by its inability to induce a thymocyte phytohemagglutinin response. In initial biochemical experiments inhibitor and enhancing factors could be separated by charge, using anion exchange chromatography. When regulatory activity of normal supernatant was compared to that of tumor-bearing mice (TBM) Mϕ supernatants, results indicated that TBM Mϕ supernatants contained a greater ability to induce MLR reactivity than their normal counterparts. Thus, it appears that the splenic T cell hyporeactivity seen in fibrosarcoma-bearing mice cannot be totally attributed to the presence of a inhibitory TBM Mϕ.

PRELIMINARY OBSERVATIONS ON METHODOLOGIES FOR ISOLATING AND ENUMERATING PATHOGENIC BACTERIA FROM SHELLFISH GROWING WATERS. Mark T. Frank* and Carl W. Erkenbrecher. Old Dominion University, Norfolk, Virginia, 23508
      The methodologies for improved recovery of pathogenic bacteria from estuarine sediments were investigated. Samples were collected from five sites horizontally distributed throughout the Lynnhaven estuary in Virginia Beach, Virginia. A review of current and past data of these shellfish growing waters has shown high fecal coliform counts in the water column and in the sediments. Our preliminary studies in these same sediments have centered around the enumeration of three pathogenic bacteria: Salmonella spp., Pseudomonas aeruginosa and Vibrio parahaemolyticus. Enrichment procedures in addition to elevated temperature techniques have been employed. Asparagine broth and dulcitol selenite broth were utilized to isolate Salmonella spp. and P. aeruginosa, while seawater yeast extract broth was used for V. parahaemolyti-cus. Genera and species have been determined by plating of these enrichment cultures on selective and differential media, followed by biochemical testing procedures. P. aeruginosa and V. parahaemolyticus-like-organisms (VPLO) have been isolated with some degree of consistency, while the Salmonella spp. have remained elusive. Preliminary results have re-emphasized the difficulties experienced by previous investigators in search of increased sensitivity techniques for detecting specific pathogens in sediments already demonstrated to be high in fecal indicator bacteria.

COMPARISON OF ANTIGENICITY OF CULTURED AND FRESHLY ISOLATED ANABAENA AZOLLAE, THE NITROGEN FIXING PHYCOBIONT OF THE AZOLLA FERN. T. Goggin*, J. Gates, P. Wood*, and R. Fisher* Dept. of Biology, Virginia Commonwealth University, Richmond, VA 23284

Antisera were prepared against freshly isolated Anabaena azollae cells from Azolla caroliniana and against Newton's culture of A. azollae, also from Azolla caroliniana. These antisera were used in a cross reaction study using indirect fluorescent antibody staining. The serum prepared against freshly isolated cells gave a strong reaction with cells of A. azollae freshly isolated from either Azolla caroliniana or Azolla microphylla. It did not react with Newton's culture of A. azollae, our culture of A. azollae, or with the free-living cyanobacteria, Anabaena cylindrica or Cylindrospermum licheniforme.

The serum prepared against Newton's culture reacted with cells from Newton's culture, our culture, and with the above named free-living species; however, it did not react with freshly isolated cells of A. azollae from either fern species.

These results indicate that either antigenic changes occur in A. azollae during culturing or that the organism cultured independently by Newton and us is not really A. azollae. They also provide evidence that the two species of Azolla have the same phycobiont, a hypothesis which heretofore has been unsupported.

PURIFICATION AND CHARACTERIZATION OF AN NADH:FLAVIN OXIDO-REDUCTASE FROM EUBACTERIUM SPECIES (V.P.I. 12708). R. H. Lipsky and P. B. Hylemon. Dept. of Microbiology, Med. Col. of Va., Richmond, Va. 23298

A NADH:Flavin oxidoreductase was purified from a Eubacterium sp. (V.P.I. 12708) using Bio-Gel A-0.5, DEAE-cellulose and affinity column chromatography. The last purification step was performed on 6-aminhexanoyl-FMN-Sepharose. Specific activity was calculated from the decrease in absorbance at 340 nm. Assays were performed anaerobically to minimize autooxidation of the reduced flavin. A molecular weight (M_r) of 260,000 was estimated by gel filtration chromatography. The partially purified enzyme preparation was found to exhibit single displacement kinetics with respect to the substrates NADH and FAD. Maximal specific activity was achieved when these substrates were in a molar ratio of 1:1. The pH optimum under these conditions was 6.8. A NADPH:Flavin oxidoreductase was also detected in crude cell extracts of Eubacterium sp. (V.P.I. 12708). However, this enzyme activity could be differentiated from the NADH-dependent flavin oxidoreductase on the basis of molecular weight (M_r of NADPH-dependent enzyme was approx. 250,000) and the differential change in the specific activity with respect to culture age.

MACROLIDE-LINCOSAMIDE-STREPTOGRAMIN R-PLASMID DERIVATIVES. F.L. Macrina, K.R. Jones* and C.L. Keeler*. Department of Microbiology, Virginia Commonwealth University, Richmond, VA 23298.

Our goal is to develop a molecular cloning vehicle for use in a Streptococcus sanguis "self-cloning" system. pAMβl is a 17 Mdal plasmid which occurs naturally in S. faecalis and confers resistance to macrolide-lincosamide-streptogramin (MLS) antibiotics. This plasmid has been introduced into S. sanguis by genetic transformation. Following transformation into S. sanguis, we have found a deletion-bearing derivative of pAMβl which we have designated pZAl. This plasmid is 7.3 Mdal in size and contains 4 Hind III restriction endonuclease cleavage sites, 2 EcoRI cleavage sites, and 1 Hpa II cleavage site. Single and double digests of this molecule with these three enzymes has allowed us to establish a provisional map of the pZAl plamid. Partial digestion of pZAl with Hind III was followed by ligation with DNA ligase and these pZAl fragments were used to transform S. sanguis to erythromycin resistance. To date, no in vitro-shortened derivatives of pZAl have been obtained by this method. (Supported by NIH-NIDR Grant DE04224.)

CHARACTERISTICS OF MACROPHAGES FROM THE BEIGE MOUSE. K.H. Mahoney*, S.S. Morse* & P.S. Morahan. Dept. of Microbiol., Va. Commonwealth Univ., Richmond, Va. 23298.

The Chediak-Higashi Syndrome (CH) is a genetic disease characterized by abnormal lysosomes in several cell types including neutrophils and macrophages (MØ). Recent evidence implicates lysosomes in MØ antitumor activity. We have defined several aspects of the antitumor activity of C. parvum activated MØ from the beige (C57BL/6J bg/bg) mouse, a CH homologue, and congenic C57BL/6 +/+ controls.

Yields of resident peritoneal cells (PEC) were similar in bg and controls (3x10^6/mouse), and about 30% MØ (by acridine orange). After treatment of mice with killed C. parvum (70 mg/kg, i.p., day -7), MØ increased to about 50% in both bg and controls. C. parvum treatment also produced similar splenomegaly in the two groups. In an in vitro 72 hr morphologic antitumor assay, bg MØ were as cytotoxic for the Lewis lung carcinoma target cells as were control MØ. Kinetics of cytotoxicity were determined in an in vitro ^{3}H-dTR release assay. The bg MØ (10:1 MØ:target cell ratio) showed a delay in cytotoxicity, at 12 hr exhibiting only 30% as much activity as controls. In spite of the delay, by 24 hrs the bg MØ had 80% of the control activity. Our results suggest that bg MØ may be deficient in some aspects of tumor cytotoxicity. This defect may be related to the delayed bactericidal activity of CH phagocytes. (Supported by CA 06332, AI 70863, CA 24686, and ACS IN-105C.)

TRANSFER OF MULTIPLE ANTIBIOTIC RESISTANCE IN CLINICAL ISOLATES OF BACTEROIDES. T.D. Mays, R.A. Welch* and F.L. Macrina. Department of Microbiology, Medical College of Virginia, Virginia Commonwealth Univ., Richmond, VA 23298.

The in vitro transfer of clindamycin and tetracycline resistance was observed from a clinical isolate of Bacteroides fragilis (V503) to a fecal isolate of Bacteroides uniformis (V528). The transfer of this multiple drug resistance was accompanied by two plasmid species: 3.7 and 7.5 megadaltons (Mdal) in size.

Bacteroides fragilis (V503) donor cells (rifampicin sensitive) were mated with spontaneous rifampicin resistant mutants of V528 on nitrocellulose membrane filters and incubated on agar plates anaerobically. Transfer frequencies of 1.8 x 10^-6 to 2.2. x 10^-7 transcipients per donor cell were observed using donor cells at different phases of growth. In this system, donor cells in the early logarithmic phase of growth appeared to transfer at a frequency 10-fold greater than cells at later stages of growth. Experiments are in progress to determine whether this increased frequency of transfer is due to the growth phase of the donor cells or an increased period of mating.

This transfer mechanism was insensitive to deoxyribonuclease I and required cell to cell contact. Transfer was not observed when either chloroform treated or 0.45 µm filtrates of donor cultures were used.

IMMUNE RETENTION: IMMUNOLOGICAL REQUIREMENTS FOR MAINTAINING AN EASILY DEGRADABLE ANTIGEN IN VIVO. G.A. MILLER, J.G. Tew, and T.E. Mandel*, Dept. of Microbiology, Medical College of Virginia, Richmond, Virginia 23298.

Radioactive human serum albumin (^{125}I-HSA) was injected into the hind foot pads of unimmunized mice, actively immunized mice, and mice passively immunized with anti-HSA. Eleven days later, the unimmunized mice had cleared the ^{125}I-HSA but in immunized mice, most was retained in the feet and draining lymph nodes, and to a lesser extent, in the spleen. Immune retention required specific antibody, but was independent of T-cells since passively immunized nude mice retained antigen as well as actively or passively immunized normal mice. Cobra venom factor (CVF) treatment increased antigen retention in the feet but decreased retention in the spleen. CVF did not decrease antigen retention in lymph nodes of actively immunized mice but did decrease retention in lymph nodes of passively immunized mice, although not to the same extent as in the spleen. Retention of antigen in the feet was Fc independent since $F(ab')_2$ fragments of anti-HSA could mediate retention. Antigen dose response studies indicated that optimal retention in lymph nodes required smaller amounts of antigen than for the feet. Foot pad injections of non-radiolabeled HSA eliminated 60% of the radioactivity retained in the foot pads of immunized mice but egg albumin (EA) had almost no effect. However, if the mice were immunized to both EA and HSA, an injection of EA would displace the HSA. Supported by NIH Grant No. AI-11101.

ENUMERATION OF ENTERIC AND OTHER VIRUSES IN WASTEWATER SLUDGES: A PRELIMINARY REPORT. M.W. Nath* and J.C. Johnson, Dept. of Biosciences, Old Dominion Univ., Norfolk, Va. 23508.

With wastewater sludge reutilization becoming more important and disposal increasingly regulated, it has become necessary to determine amounts of specific and hazardous pollutants in sludges. Viruses are a class of biologically hazardous pollutant found in varying amounts in sludge and upon occasion have been demonstrated the etiologic agents responsible for human disease. Improvements in detection and enumeration of viruses in wastewaters are being sought. We have studied the ability of common surfactants [sodium dodecyl sulfate (SDS), tweens 20 (T-20) and 80 (T-80), Nonidet P40 (NP-40), tritons X-100 (X-100) and X-200 (X-200)], fetal bovine serum (FBS), beef embryo extract (BEE), and NaCl to extract poliovirus-2 (Po-2), coxsackievirus B2 (Cox-B2), and Anatid herpesvirus (AHV) from seeded wastewater sludge. Surfactant concentrations found to be non-cytotoxic were equal to or less than 0.05% v/v. Po-2 was most efficiently plaqued on RD (CCL-136) followed by buffalo green monkey (BGM), VERO (CCL-81), and WI-38 (CCL-75); Cox-B2 on BGM followed by WI-38, VERO, and LLC-MK$_2$ (CCL-7.1); and AHV on duck embryo fibroblasts (DEF) exclusively. The efficiency of extraction of enteric viruses was least using T-20 or T-80 ($\cong$15%) and greatest using either SDS or NaCl ($\cong$75%) in single extraction at 4°C and greater than 95% using SDS and NaCl in single or double extraction at 15°C.

PAPER RADIOIMMUNOSORBENT ASSAY FOR THE DETECTION OF HEPATITIS B VIRUS ANTIGENS AND ANTIBODIES. N.J.Reedy, P.D. Swenson, H.M. Syrop, and M.R. Escobar. Med. Coll. of Va.- Va. Comm. Univ., Richmond, Va.

The collection of blood, its handling and processing for the detection of various markers of Hepatitis B virus infection is impractical and hazardous, especially for field testing. In this study, a simple procedure was evaluated, consisting of spotting a drop of whole blood from a finger puncture on a 2x2 cm square of Whatman #4 filter paper. The paper was dried, placed in a polypropylene tube and refrigerated until tested. Prior to testing, it was immersed for 30 minutes in 3 ml of 0.85% NaCl. The resulting suspension and serum from the same patient were then tested by the AUSRIA-II, AUSAB, and CORAB techniques. HBsAg positive results done in triplicate from the paper method correlated 100% for sensitivity and specificity with those using serum. In contrast, the paper method only detected 67% and 25% of the serum specimens found to be positive by AUSAB and CORAB, respectively. Further work is underway to increase the sensitivity by the latter two methods.

TRANSCRIPTION OF THE NONDEFECTIVE BOVINE PARVOVIRUS. J. T. Patton, E. R. Stout, and R. C. Bates, Dept. of Biology, Va. Poly. Inst. and State Univ., Blacksburg, Va. 24061.

Viral-specific RNA (vRNA) produced in bovine parvovirus (BPV)-infected bovine fetal spleen cells continuously labeled with ^{3}H-uridine was examined by hybridization, poly(U)-Sepharose chromatography, and gradient centrifugation. The levels of BPV-specific RNA late in infection were examined by exhaustive hybridization in 50% formamide. vRNA represented 3.1, 3.2, and 6.8% of the RNA found in the total cell, nuclei, and polysomes, respectively. Separation of the nuclear and polysomal RNA by poly(U)-Sepharose chromatography into poly(A)+ and poly(A)- fractions, followed by hybridization, showed that 18.2 and 25.4% of nuclear and polysomal poly(A)+ RNA respectively was vRNA while 3.1 and 6.1% the nuclear and polysomal poly(A)- RNA was vRNA. These results suggest substantial levels of polyadenylation of the BPV vRNA.

The template specificity of vRNA was determined by competitive hybridization of ^{3}H-vRNA and BPV vDNA for immobilized BPV vDNA-cDNA. Competition of vRNA and 10 μg of vDNA resulted in 2.4% vRNA binding to the immobilized DNA suggesting that the template for polysomal poly(A)+ vRNA (viral mRNA) is BPV vDNA. Polysomal poly(A)+ RNA was sized by centrifugation through 0-15% sucrose containing 99% dimethyl sulfoxide. Subsequent hybridization of fractions from the gradient indicated a major peak of vRNA at 25-26 S which corresponds to a transcript length which is 70-80% of the BPV genome.

LONG-TERM ANTIGEN RETENTION ON MOUSE TENDONS: A MECHANISM FOR INDUCTION OF LOCAL HYPERSENSITIVITY STATES. Patricia L. Rice, John G. Tew, and Terrell A. Thompson. Department of Microbiology, Med. Col. of Va., Richmond, Va. 23298.

It has been reported by our laboratory that human serum albumin (HSA), an antigen (Ag) easily degraded in vivo, is retained intact for long periods of time (T$\frac{1}{2}$ = 2mo) in the feet, lymph nodes, and spleen of HSA-immune mice. The same situation is not seen in non-immune mice, instead the Ag is rapidly cleared from these sites. The objective of this study was to establish where in the foot Ag was retained, and to determine if a hypersensitive state could be locally and specifically induced at the site of Ag retention in the foot. ^{125}I-HSA was injected into the hind feet of HSA-immune and non-immune mice. Autoradiography of the feet revealed that the majority of the ^{125}I-HSA was found in association with the flexor tendon. Injecting small amounts of HSA into feet retaining HSA elicited foot pad swelling. Also, it was found that in mice immunized months earlier foot pad swelling could be induced by administering specific Ag by gavage or injecting it intraperitoneally. In contrast, the feet of mice primed by routes other than the foot pad, or foot pad immunized mice challenged with non-specific Ag, did not swell. The data suggest a possible mechanism for the induction of hypersensitivity states since it appears that minute amounts of Ag in the circulation can act in conjunction with Ag retained on the flexor tendon to elicit an inflammatory response at the local site. (USPHS NIH Grant AI-11101)

ISOLATION OF TEMPERATURE-SENSITIVE ALGINIC ACID BIOSYNTHETIC MUTANTS OF MUCOID PSEUDOMONAS AERUGINOSA. R. Robins*, D.O. Wood*, J.S. Karns*, F.L. Macrina and P.V. Phibbs, Jr. Dept. of Microbiology, Virginia Commonwealth Univ., Richmond, VA.

Alginic acid-producing mucoid strains of Pseudomonas aeruginosa frequently cause chronic respiratory infections in cystic fibrosis patients. We report the isolation of mutants affected in the biosynthesis of this exopolysaccharide. A mucoid, clinical isolate (V388) produces an increasing amount of extracellular alginate as the temperature rises with peak production (45 μg per 10^9 cells at 32C, 68 μg per 10^9 cells at 37C, and 90 μg per 10^9 cells at 42C) occurring at the end of log phase growth in basal salts glucose medium. A spontaneously occurring, non-mucoid variant (V389) grown under similar conditions produces no detectable alginate when assayed for uronic acids using a colorimetric borate-carbazole method. Mid-log phase cells of V388 were exposed to ethyl methanesulfonate. Survivors were plated on a complex medium and incubated at 42C. Non-mucoid colonies appearing after 24 hr were selected and observed for the mucoid phenotype when grown at 32C for 24 hr. One mutant (V578) isolated in this manner exhibits a growth rate indistinguishable from that of V388, but produces alginate at greatly reduced levels, especially at 42C (17 μg per 10^9 cells at 32C, 31 μg per 10^9 cells at 37C, and 12 μg per 10^9 cells at 42C). This work was supported by a grant from the National Cystic Fibrosis Foundation.

THE EFFECT OF GLUCOSE STARVATION ON THE GLUCOSE TRANSPORT SYSTEM OF THE YEAST KLUYVEROMYCES LACTIS. Paulette W. Royt. Biology Department, George Mason University, Fairfax, Va. 22030

The inducible glucose transport system of the yeast Kluyveromyces lactis is rapidly inactivated upon glucose starvation. This inactivation does not require energy. An inhibitor of RNA synthesis, 8-hydroxyquinoline, has no effect on the loss of activity. In the absence of both glucose and nitrogen inactivation does not occur, whereas nitrogen starvation in the presence of glucose results in a moderate decrease of carrier activity. Glucose-starved, wild type cells require glucose, nitrogen, and RNA synthesis to regain transport activity. A uracil-requiring mutant of this yeast requires uracil as well as glucose to regain carrier capacity. These results suggest that the glucose carrier of this yeast is subject to proteolytic modification by an existing protease, for to restore transport activity following glucose starvation synthesis of new carrier molecules must occur. (Aided by GMU Research Grant 2-10013)

NEW SOLID-PHASE IMMUNOFLUOESCENCE METHOD FOR SYPHILIS. R. J. Talliaferro, M.R. Escobar, J.N. Reedy and C.W. Moncure. Med. Col. of Va.- Va. Comm. Univ., Richmond, Va.

The Fluorescent Treponemal Antibody-Absorption (FTA-ABS) test is the conventional qualitative procedure for detection of antibodies to Treponema pallidum. Although it is highly sensitive, it is subjective, time-consuming, and tedious for routine testing. This study was concerned with the adaptation of the FTA-ABS to a recently developed fluoroimmunometric assay system (FIAX) using a cellulose acetate reacting surface. Several parameters were tested, including optimal buffer, pH, conjugate dilution, antigen concentration as well as the effect of various agents on specificity and reactivity. A total of 195 sera and 45 cerebrospinal fluid (CSF) specimens were tested under standard conditions. Of 150 FTA-ABS reactive sera, 147 (98%) were also reactive by FIAX. Of 45 FTA-ABS nonreactive sera, only 34 (76%) were nonreactive by FIAX. Of 43 FTA-ABS nonreactive CSF, 42 (98%) were also nonreactive by FIAX. Of the other 2 FTA-ABS reactive CSF, only 1 was reactive by FIAX. Of 35 FTA (unabsorbed) nonreactive CSF, 100% were nonreactive by FIAX. Of the 10 FTA reactive CSF, only 2 (20%) were reactive by FIAX. Further investigation on the basis of a close clinicolaboratory correlation is warranted to determine the comparative specificity of the two methods. Advantages of the FIAX include objectivity, automation, potential for quantitation and simplicity which justify its further evaluation.

COMPARISON OF HETEROCYSTS IN FREE-LIVING CYANOBACTERIA AND THE PHYCOBIONT OF THE AZOLLA FERN. P. Tomlinson*, R. Fisher* and J. Gates. Department of Biology, Virginia Commonwealth University. Richmond, Virginia 23284.

In nature, the water fern Azolla normally forms a symbiotic association with the cyanobacterium Anabaena azollae. This association can fix diatomic nitrogen and can therefore be important agriculturally. The site of this nitrogen fixation is in special cells of the cyanobacterium, called heterocysts. In our studies with A. azollae we have sought a rapid and accurate method to identify heterocysts.

In the course of our studies with the Azolla complex, we have noticed a difference in the fluorescence spectra of vegetative cells and heterocysts. The heterocysts of all free-living cyanobacteria examined failed to fluoresce when excited with 530 nm light. The vegetative cells did fluoresce. This difference makes it possible to identify heterocysts. However, heterocysts of A. azollae did fluoresce, thus making the fluorescent method ineffective. Other methods, utilizing nuclear emulsion, nitro blue tetrazolium (NBT) , and triphenyl tetrazolium chloride (TTC), were examined for use with A. azollae heterocysts. NBT was shown to be the best.

The nature of the difference in the fluorescence of the heterocysts of free-living cyanobacteria and those of A. azollae is now under study.

CHARACTERIZATION OF BACTEROIDES R PLASMID DELETION MUTANTS. R.A. Welch* and F.L. Macrina. Dept. of Microbiology, Med. College of Virginia, Virginia Commonwealth Univ., Richmond, VA 23298.

Bacteroides fragilis strain V514 possesses a transferable R plasmid, pBF5 (60 Mdal), which confers resistance to clindamycin, erythromycin and tetracycline. A spontaneously occurring tetracycline sensitive variant of V514 has been isolated (V479-1) which possesses a 27.3 Mdal plasmid, pBF4, conferring transferable clindamycin and erythromycin resistance. Following growth in the presence of ethidium bromide, clindamycin-erythromycin sensitive variants of V479-1 and V514 have been isolated. Reversion by these strains to clindamycin resistance is undetectable ($<10^{-9}$) even when cells are grown in the presence of various mutagens. Plasmid size analysis of clindamycin sensitive derivatives of V479-1 and V514 indicate that the pBF4 and pBF5 plasmids have undergone a deletion amounting to 5 Mdal of DNA. When the deletion-bearing plasmid derivatives are digested with restriction endonucleases, the deletions can be associated with the loss of specific digest fragments, thus enabling us to localize the clindamycin resistance determinant. (Supported by NSF Grant PCM 77-00858.)

WATER-TO-AIR TRANSFER OF POTENTIAL MYCOBACTERIAL PATHOGENS IN RICHMOND. S.L. Wendt*, B.C. Parker, and J.O. Falkinham, III. Dept. of Biology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Our data show that potentially pathogenic atypical mycobacteria of the Mycobacterium avium-M. intracellulare-M. scrofulaceum (MAIS) -group occur in James River freshwater, their aerosols, and rainwater from Richmond, Virginia. The recovery of 21 strains of MAIS-group mycobacteria, biochemically similar to those isolated from man, confirms the existence of a natural mechanism for the transfer of significant numbers of atypical mycobacteria from their freshwater reservoirs into the air. Four aerosol isolates were associated with droplets of a size capable of penetrating the human alveoli and 10 others could be infective if their associated droplets decreased in size via desication. Atypical mycobacteria are more abundant in freshwaters than marine waters of the southeastern United States and are less commonly recovered from samples from the northeastern states. These findings support our hypothesis that aerosolization of atypical mycobacteria from waters of the southeastern United States may be important for human infection.

RADIOLABELING IN NAEGLERIA. T.W. Woodworth*, S.G. Bradley, H.L. Pringle and W.M. Holmes. Dept. Microbiology, Va. Commonwealth Univ., Richmond, VA 23298

Naegleria fowleri and N. gruberi are amoeboflagellates that feed and grow as amoeboid cells but can transform into flagellated cells within 1 hr after nutrient deprivation. N. fowleri is the agent of primary amoebic meningoencephalitis in man; N. gruberi is non-pathogenic. Both species normally inhabit fresh water environments. N. fowleri may be cultivated axenically in Nelson's medium (0.1% liver digest, 0.1% glucose and 2% calf serum in inorganic salts), growing with a generation time of 12.7 hr to a yield of 1.2×10^6 amoebae/ml. N. gruberi has been grown axenically in Balamuth's medium (0.5% yeast extract, 0.5% glucose, 1% liver digest, 1% proteose peptone in inorganic salts) with a 7.4 hr generation time to a yield of 3×10^6 amoebae/ml. For radiolabeling, Balamuth's medium is too complex. One strain of N. gruberi, NEG-M, has been cultivated in M7 medium (0.5% yeast extract, 0.03 mM glucose, 0.3 mM methionine, 8% dialyzed calf serum and phosphate buffer). N. fowleri incorporates adenine, uridine, thymidine, leucine and serine but not sulfate during growth in Nelson's medium. N. gruberi NEG-M, during growth in M7 medium, incorporates methionine, but not glutamate, aspartate, leucine, serine or sulfate, into trichloroacetic acid precipitable protein. Optimization of axenic growth and radiolabeling is a necessary prelude to future studies of macromolecular events accompanying the amoeba-flagellate transformation. Work supported by ACS Grant (IN-105 D.)

FOCAL HEPATIC NECROSIS IN VARIOUS STRAINS OF MICE AS A MARKER FOR HERPESVIRUS HOMINIS TYPE DIFFERENTIATION. J.M. Yanni, M.R. Escobar, N.J. Reedy and H.M. Syrop. Med.Col. of Va.- Va. Comm. Univ., Richmond, Va.

The production of focal, macroscopic, hepatic necrosis in mice as a marker for differentiating Herpesvirus hominis type 1 (HVH-1) from type 2 (HVH-2) was investigated. AKR-J, BALB/cByJ, C57BL/6J and ICR mice were evaluated and compared as models. The AKR/J and ICR strains produced hepatic lesions following intraperitoneal inoculation of both HVH-1 and HVH-2. The C57BL/6J mice exhibited no lesion production following injection with either virus type. In contrast, BALB/cByJ animals showed 100% specificity and 70% sensitivity of lesion production following injection with HVH-2, respectively. The relatively low degree of sensitivity appears to be the limiting factor in the focal hepatic necrosis test. This method was compared to the plaque assay in chicken embryo fibroblast monolayers, indirect hemagglutination inhibition, direct immunofluorescence and pock production on the chorioallantoic membrane of embryonated chicken eggs, thus showing good correlation with all, except the latter procedure. For this reason, focal, hepatic necrosis was proposed as a confirmatory test or as a member of a battery for HVH type differentiation.

ELECTRON MICROSCOPIC VISUALIZATION OF BOVINE PARVOVIRUS DNA.
R. B. Young and R. C. Bates, Dept. of Biology, Va. Poly.
Inst. and State Univ., Blacksburg, Va. 24061.
   The parvoviruses contain a linear single-stranded DNA
genome with palindromic sequences at the 3' and 5' termini.
The proposed Berns and Hauswirth model for replication of
these viruses calls for the conversion of the single-
stranded DNA to a duplex replicative form using the 3'
palindrome or hairpin as a primer for DNA synthesis.
Progeny DNA strands are produced by a single strand dis-
placement mechanism resulting in partially duplex
replicative intermediates with single-stranded side chains.
Dimer and trimer length replicative forms are also postu-
lated. We report the extraction and purification of
several low molecular weight DNA species from bovine parvo-
virus-infected cells that could not be demonstrated in
mock-infected cells. Characterization of these viral DNA
species by electron microscopy demonstrated linear duplex
molecules with a mean length of 1.69 μm. These are postu-
lated to be replicative form DNA. Duplex molecules
significantly longer than the replicative form DNA with
lengths of 2.99 μm. and 3.99 μm. were also observed. The
lengths of these molecules approach calculated values for
dimer and trimer replicative forms. No branched molecules
were observed.

Psychology

Fifty-seventh Annual Meeting of the Virginia Academy of Science
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A RE-EXAMINATION OF THE ROLE OF THE LATERAL HYPOTHALAMUS AND AMYGDALA IN PREDATORY AGGRESSION USING KAINIC ACID LESIONS. R. W. BATES*. Sponsor: L. E. Jarrard. Dept. of Psychology, Washington & Lee Univ., Lexington, VA 24450

The lateral hypothalamus and amygdala are part of a predatory aggression circuit. Stimulation of either of these structures elicits (or facilitates) murocide in rats. Conventional bilateral ablation of either of these structures causes loss of murocide in mice killing rats.

Kainic acid lesions were used in the present research since these cause no damage to passing fibers as is the case with conventional lesions. The question explored was whether the predatory aggression circuit would stay intact if only the cell bodies and not passing fibers of the amygdala and lateral hypothalamus were destroyed.

Results from lateral hypothalamic lesions were inconclusive. Extensive bilateral damage was obtained in the amygdala of two rats and a third rat had limited bilateral damage. The murocide tendency of these animals was as strong as in the controls. This suggests that passing fibers play an important role in predatory aggression in rats.

THE EFFECTS OF 36 HOURS OF SLEEP-LOSS ON INFORMATION PROCESSING USING A DIGIT CANCELLATION TASK. R. A. Brogan*, R. H. Kirby, and B. B. Morgan, Jr. Dept. of Psychology, Old Dominion Univ., Norfolk, Va. 23508

Two groups of subjects, each consisting of 6 males and 6 females, were tested in a study of the effects of 36 hours of sleep-loss (SL) on a digit cancellation task. SL subjects were tested nine times during various stages of sleep loss and 24 hours after the end of the SL period. The control subjects were tested daily for an equal number of times but did not undergo sleep loss. Results showed that sleep loss significantly impaired the improvement of the SL subjects, as compared to the controls. Following 24 hours of rest at the end of sleep loss, the performance of the SL subjects was not different from that of the control subjects.

BEHAVIORAL APPROACHES TO PROMOTING ENERGY CONSERVATION IN A TOWNHOUSE COMMUNITY SETTING. S. E. Churchill*, J. J. Carlyle*, A. W. Fisher*, and J. F. Ferguson*. Sponsor: E. S. Geller. Dept. of Psychology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

An interdisciplinary team of faculty and students at VPI & SU initiated a grant-supported project in the Fall of 1978, entitled Community Action Model for Energy Conservation (CAMEC). The group demonstrated that while energy workshops did promote energy-conservation attitudes, little or no short-term behavioral changes occurred as a result of the workshops. Subsequently, CAMEC initiated a project in a townhouse community to both test the effectiveness of neighborhood workshops and to develop and test new strategies for promoting energy conservation. These strategies included: neighborhood "tupperware-like" workshops, distribution of information packets, energy "hotline" and energy consultant telephone numbers, computer audits of energy usage, and energy usage feedback. Results indicated that these strategies had minimal influence on conservation action, even when the conservation strategy was as convenient as dialing a phone number or completing a simple computer form.

PRELIMINARY EXAMINATION OF ATTITUDES OF THE INDIGENTS OF ROANOKE'S "BLOCK". J. M. Collins*, and A. V. E. Harris. Dept. of Psychology, Radford Col., Radford, Va. 24142

The current study was an attempt to ascertain self-perceptions of indigents on Roanoke's "block"--an area bordering the city market. Based on previous work by the same author approximately 50 residents of the "block" were personally interviewed regarding their behavior. Most reported a dislike for the conditions under which they lived although most reported pleasure with the cheapness of living, and the presence of others in the same position as they were. While many answers to questions were ambiguous it appeared that alcoholic overindulgence on the part of other residents and the potential for assault were factors most disliked about the area.

So, while many report satisfaction with the block overwhelming evidence points to the fact that the commonly held belief that the block is a tightly knit, well integrated, organized community is a complete myth.

THE COMPUTER AS A GRADE BOOK. James V. Couch. Dept. of Psychology, James Madison Univ., Harrisonburg, Va. 22807.
    A general purpose computer program is described which provides individualized student printouts and three different distributions of the student's total scores for the entire class. The advantages of using the computer to perform various data transformations in relation to grading is disucssed.

A THERAPIST-CONTROLLED BEHAVIOR MODIFICATION PROCEDURE FOR WEIGHT REDUCTION. L. E. Elliott*, M. Elliott*, and S. B. Lovett. Dept. of Psychology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061
    A therapist-controlled behavior modification procedure for gradual weight reduction was introduced on a reversal design to four obese subjects for 63 weeks. The procedure involved presentation of informative feedback, praise or reproof, and information concerning specific eating behaviors. At the end of the treatment, the subjects had lost an average of 35 pounds. They had regained less than one pound when weighed seven weeks later.

FACTOR ANALYTIC STUDY OF THE ALPERT-HABER ACHIEVEMENT ANXIETY TEST. Terry Garber,* W.E. Turner*, B. English*, C. Grey*, W. Riley*, and J. V. Couch. Dept. of Psychology, James Madison University, Harrisonburg, Va. 22807.
    The Achievement Anxiety Test (AAT) was developed by Alpert and Haber in 1960 and purports to indicate not only the presence or absence of test anxiety but also whether the anxiety is of a facilitative or debilitative nature. The test consequently yields two subscores of test anxiety: facilitative and debilitative. The current research sought to determine if the AAT does in fact measure these two kinds of anxiety. The AAT responses of approximately 400 undergraduates were factor analyzed. Correlational data were also obtained between facilitative and debilitative subscores and grade point average. Preliminary results tend to indicate that the AAT is a more effective measure of debilitative anxiety than facilitative anxiety. Several implications and considerations of these results are discussed.

SPATIAL DISTANCE AND SOLIDARITY AS DETERMINANTS OF SOCIAL CONFORMITY. K. L. Hearn*, C. K. Cuddihy*, E. M. Jenkins*, and S. E. Arnold*. Dept. of Psychology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.
    Our previous research, which manipulated spatial distance between individuals in a social conformity paradigm, demonstrated that social conformity was a direct function of the spatial distance between individuals. The present study manipulated group solidarity in a task immediately preceeding a social conformity paradigm in an attempt to influence the extent to which close spatial distance would be perceived as an invasion of personal space.
    In summary, the task was a 2(Solidarity: group task versus individual task) x 3(Spatial Distance: inter-subject distance during conformity paradigm-one, four, or eight feet) x 2(Sex of Subject: male versus female) between subjects complete factorial design, with six subjects per condition making a total of 72 subjects.
    Questionnaire data verified that manipulations in the initial task affected solidarity in the predicted directions with subjects conforming more following the High Solidarity Condition than following the Low Solidarity Condition. Conformity, however, was not influenced by spatial distance. Additional follow-up research was undertaken to determine moderating factors which determine whether spatial distance influences social conformity.

A COMPARATIVE STUDY OF DIRECTIVE AND NON-DIRECTIVE APPROACHES TO COUNSELING THE MULTIPLY HANDICAPPED. S. H. Patterson, E. Jenkins*, G. A. Hayes*, and E. Scott Geller. Dept. of Psychology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.
    The comparative effectiveness of two approaches to counseling (directive and non-directive), as employed by undergraduate college students in a therapeutic camp setting, was investigated. The campers were institutionalized, multiply handicapped individuals, classified as severely to profoundly retarded, with a variety of physical disabilities. Prior to camp week, counselors were given 12 hours of general instruction in camper limitations and disabilities, and activity procedures during camp week. Six hours of specific training in both directive and non-directive counseling techniques was provided, via role-playing, group discussion, and direct instruction. Counselors were randomly divided such that half began with the directive approach and switched to the non-directive approach at mid-week and half began with the non-directive approach and switched to the directive. Counselors rated the directive technique significantly more effective on 19 of 20 dimensions tapped, including overall successfulness, effectiveness, efficiency, practicality and involvement. Other dimensions will also be discussed, along with some suggestions for enhancing counselor competency with minimal training.

THE EFFECTS OF KAINIC ACID LESIONS OF THE AMYGDALA ON SPATIAL LEARNING. Andy D. King*. Sponsor: L. E. Jarrard. Dept. of Psychology, Washington & Lee Univ., Lexington, VA 24450
    The involvement of the amygdala in spatial memory was studied in the rat by employing an eight-arm radiating maze. Previous lesioning techniques of the amygdala have destroyed fibers of passage in addition to the cell bodies. In the present study kainic acid was used because it selectively destroys the cell bodies of the structure. Six male albino rats were trained preoperatively to visit all eight arms of the maze without repeating alleys. Bilateral lesions were then made by injecting kainic acid into the amygdala. Following damage to the amygdala cells, the animals performance in postoperative retention did not differ significantly from controls. Thus these results suggest that the amygdala does not play an important role in retention of spatial information.

PSYCHOMOTOR SPEED AS AN INDEX OF ORGANISMIC INTEGRITY.
H. E. King. Dept. of Psychology, Washington and Lee Univ.,
Lexington, Va. 24450
     The existence of a systematic relation between states
of human behavior disorder and faulty psychomotor func-
tioning may be considered, by now, to be an experimentally
well-established phenomenon. Psychomotor adequacy has been
found to be affected to a measurable degree whenever severe
disruptions of adaptive behavior are noted, whether these
be of physiologic, psychiatric, or neurologic origin. The
empirical evidence supporting this broad statement of con-
tingency will be reviewed, drawing on experimental findings
based on populations of psychotic subjects, the brain-
damaged and the mentally retarded, from the consequences
of human brain-surgical procedures and lower-brain elec-
trical stimulation and from the data of normal subjects
performing psychomotor tasks under the influence of drugs,
deprivation of essential sleep or oxygen and other manip-
ulated experimental conditions. The parallel found between
behavior disorder and the vigor of psychomotor responding
offers a practical method for making public and measurable
what appears to be a vital aspect of organismic integrity,
bringing together for quantitative comparison kinds of
behavior disorganization usually thought to be quite
independent entities.

SPATIAL LEARNING IN THE RAT AS A FUNCTION OF THE NUMBER OF
REWARDED ALTERNATIVE RESPONSES. J. A. Lutins*, W. T.
Thistlethwaite*, D. G. Elmes, and J. B. Thompson*. Dept. of
Psychology, Washington & Lee Univ., Lexington, VA 24450
     The purpose of this study was to examine the memory
processes that underlie spatial cognition in the rat. We
were interested in the contributions of working memory,
the within-trial record of behavior, and reference memory,
the long-term record of rewarded loci, on the performance
of rats on an eight-armed radial maze. Rats were randomly
divided into eight groups, and each subject was required to
learn which arm or arms of the eight-armed maze were baited.
Group 1 had one baited alley, Group 2 had two baited alleys,
and so on through Group 8, which had all eight arms baited.
Rats in Groups 1 and 8 performed best as they reached a
learning criterion well before the animals in any other
group. It was hypothesized that performance in Groups 1
and 8 was best because only one of the two memory systems
was required for adequate performance in those groups. On
the other hand, animals in the remaining groups (2-7 baited
alleys) must utilize differing amounts of both working and
reference memory, which results in poorer overall perform-
ance. Adequate spatial cognition in the rat requires an
efficient use of both reference and working memory.

PROGRESSIVE RELAXATION VERSUS RATIONAL SELF
ANALYSIS: TOWARD A SELF-DIRECTED REDUCTION OF
ANXIETY. William T. Riley*. James Madison
University, Harrisonburg, Va. 22807
     Relaxation has been extensively used on
college campuses to reduce anxiety. However,
little has been done to compare short-term, self-
directed relaxation to Rational Self Analysis(RSA)
In this study, students randomly selected who
received anxiety scores of one standard deviation
or higher as measured by the trait portion of the
State-Trait Anxiety Inventory were randomly
assigned to either a RSA condition, a relaxation
condition, or a control condition. Full data
was available for 35 students. Both the RSA and
relaxation groups attended two sessions of $1\frac{1}{2}$
hours each. Post tests were given one to three
months after the sessions. It was found that
RSA was significantly more effective than
relaxation ($\underline{F}(2,32)=5.28$, $p<.025$) and significant-
ly more effective than the control group($\underline{F}(2,32)=$
18.55, $p<.001$) in the reduction of trait anxiety.
It was concluded that for clients with a large
degree of internalization and introspection, such
as college students, RSA is a more effective self-
directed technique than relaxation in the reduc-
tion of anxiety and should be utilized more exten-
sively in the college setting.

PRELIMINARY STUDIES OF HUMAN STRESS BEHAVIOR WITH
THE PSYCHOLOGICAL STRESS EVALUATOR. Michael P.
Kradz* and John C. Bartone, American Health Re-
search Institute, Annandale, Virginia 22003.
     The Psychological Stress Evaluator (PSE) is a
new instrument on the scene of science and horizon
of medicine. Publications are rare. Unpublished
research is spreading but remains devoid of peer
supervision. Controversy concerns the PSE, as any
new instrument that must gain universal approval.
Stress, medical and psychic, in subjects contributes
vast complications which worsen with different be-
havioral patterns and attitudinal development.
     The PSE principally records sub-sonic vocal vi-
brations of the stressed or non-stressed vocalis
muscle of the human larynx.
     High stress factors (forgery, drugs, larceny and
homocide) were tested in order to examine the relia-
bility of the PSE and validity of suspects' data.
Selected criminal cases, chosen to serve as controls
provided dual causal relationships: (1) high human
stress and (2) proven criminalistic and forensic
data yielding definitive suspects' guilt which en-
hanced stress and removed all doubts of innocence
of suspects. Proved guilt provided positive control
data for these experiments. Comparably, the PSE
herein offers a valuable (diagnostic?) aid for anal-
ysis of high stress crime and behavior of suspects.

THE EFFECTS OF KAINIC ACID LESIONS OF THE AMYGDALA ON EATING
AND DRINKING. Paul A. Nathan*. Sponsor: L.E. Jarrard. Dept.
of Psychology, Washington & Lee Univ., Lexington, VA 24450
     The activity of the amygdala is of paramount importance
in determining what the animal will and will not eat. Stud-
ies indicate that lesion removal of the amygdala causes
the animal to be less neophobic about most learned things
including comestible and libatious substances. The lesion-
ing technique employed involved the use of kainic acid (KA).
KA was used because of its excitotoxic ability to destroy
nuclei rather than the fibers that pass through or terminate
in the area; consequently, more specific lesions are
possible.
     The experiment tested four experimental and four matched,
sham operated control rats. Their eating and drinking be-
havior relative to rat chow vs. sugar cookies vs. saltines
vs. onion crackers and water vs. 0.05% saccharin solution
were measured. KA (0.20 ug) was bilaterally administered
over a fifteen minute period. The water consumed in the
rat's home cage was also measured. Results suggest that
amygdaloid removal via KA increases the frequency and amount
of eating novel foods. The experimentals also showed greater
preference for the saccharin solution over tap water. There
were no differences in the amount of water consumed in the
home cage. These results suggest that damage to the "fibers
of passage" does not account for previous results and thus
implicate the amygdala as being important in basic consum-
matory behaviors.

THE "REFLECTIVE" DREAM THEORY: AN ANALYSIS OF THE RELATION-
SHIP BETWEEN TRAIT ANXIETY AND FREQUENCY OF ANXIETY DREAMS.
Paul W. Stairs*, and Kenneth A. Blick. Dept. of Psychology,
Univ. of Richmond, Richmond, Va. 23173
     The purpose of the experiment was to test the continuity
between personality traits exhibited during wakefulness and
manifest dream content. The correlation between percentile
scores of a trait anxiety scale and the incidence of anxiety
as reported in dream diaries submitted by 31 undergraduates
was found not to be significant. A frequency analysis of
the emotional content of 155 dreams revealed no significant
sex difference; however, certain emotions appeared signifi-
cantly more often than others. Interest, fear, surprise,
and enjoyment accounted for the majority of the emotions
reported. Although no direct evidence was established to
support the reflective theory, a format for the study of
the emotional content of dreams was delineated.

ATTEMPTS TO ENHANCE RESIDENTIAL ENERGY CONSERVATION: ATTITUDINAL VERSUS BEHAVIORAL IMPACT. H. P. Wheeler*, K. L. Larson*, J. F. Ferguson*, and E. S. Geller. Dept. of Psychology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

An interdisciplinary team of professors and students at VPI & SU has been evaluating, implementing, and promoting large scale procedures to increase energy conservation in community settings. This Community Education Model for Energy Conservation (CEMEC) is an ongoing HEA Title I project which began in the Spring of 1977, and combines expertise from architecture, physics, education, civil engineering, and psychology to develop and evaluate strategies for conserving energy. During 1977 and 1978, CEMEC organized and delivered educational workshops covering such topics as space conditioning, insulation, water heaters, and behavioral strategies for energy conservation, and assessed the attitudinal and behavioral impact of these workshops. CEMEC designed and implemented energy conservation workshops for three sectors of the community (consumer, commercial and governmental) regarding three major targets for energy consumption (transportation, buildings and equipment) with two basic strategies: physical (i.e., engineering technology) and psychological (i.e., behavioral science). In general, these workshops both increased public awareness as to the seriousness of the energy shortage, and changed participants' energy attitudes/opinions in the targeted directions; but field assessment indicated minimal behavioral effects.

ADAPTATION TO DELAYED VISUAL FEEDBACK WITH NON-DELAYED PROPRIOCEPTIVE AND VISUAL FEEDBACK TRAINING TRIALS. M. E. Witherspoon*, Child Develop. Ctr., Lynchburg Training Sch. and Hosp., Lynchburg, Va. and A. V. E. Harris, Department of Psychology, Radford College, Radford, Va. 24142.

This research examined motor tasks performed under conditions of delayed visual feedback (using a delay of 4.6 sec.). Prior experience with similar and dissimilar feedback conditions was given. Seventy (70) right-handed female undergraduate college students were given either 5, 10, 20 or no prior trials with a six-pointed star maze task in which each subject received either visual-proprioceptive or proprioceptive-only feedback. All subjects then performed a maze drawing task in a blind performance condition with either delayed or non-delayed televised visual feedback presented concurrently with each attempt. No adaptation to delayed visual feedback was observed, except for a significant difference in performance times for subjects who received different amounts of only proprioceptive feedback. On the basis of the data collected, it was concluded that timing factors are a critical factor in the control of visually monitored movements. The roles of visual and proprioceptive feedback in the control of such movements remains undetermined. Possible explanations for the absence of observable adaptation are discussed.

Space Science and Technology

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THE SPACE SHUTTLE PROGRAM. James P. Arrington,* Assistant Head, Vehicle Analysis Branch, NASA Langley Research Center, Hampton, Va. 23665.
The NASA has been developing the Space Shuttle as a reusable space transportation system for the past several years, and the first orbital vehicle, the Columbia, is presently being made ready for its first flight into space. A brief overview of the Shuttle Program will be given which will include a description of the Shuttle components; a general overview of the program management; a brief history of the orbiter 101, the Enterprise, that will include a movie describing the ferry and the approach and landing tests; and the status of the orbiter 102, the Columbia. The unique features of the Shuttle will be emphasized during a review of the mission profile which highlights the role of each component of the system. Emphasis will be given to the variety of payloads that will be delivered into near-Earth orbit. In particular, the benefits that can result from having easy access to space will be highlighted.

THE ROLE OF METHANE ON STRATOSPHERIC WATER VAPOR DISTRIBU- TION. T. T. Augustsson* and S. N. Tiwari. Dept. of Mech. Engnr. and Mechanics, Old Dominion Univ., Norfolk, Va.23508
Theoretical considerations suggest that for each methane molecule (CH_4) that is completely oxidized one carbon diox- ide molecule (CO_2) and two water vapor molecules (H_2O) result. In situ measurements in the stratosphere have shown that the mixing ratio of water vapor is approximately twice that of methane. A time-independent one-dimensional tropo- spheric-stratospheric photochemical model has been utilized to investigate a potential chemical link between methane and water vapor. The photochemical model is coupled with a one- dimensional radiative-convective model that calculates the atmospheric temperature profile since both carbon dioxide and water vapor are thermally active species. In addition, increased stratospheric water vapor will decrease strato- spheric ozone (O_3) via the HO_x catalytic cycle. Calculations indicate that there is a moderately strong link between meth- ane and water vapor in the stratosphere. Oxidation of methane does increase the concentration of water vapor molecules, but below the expected rate.

PYROELECTRIC DETECTORS FOR SPACEBORNE POLLUTION MONITORING. Ivan O. Clark*. Flight Electronics Division, NASA, Langley Research Center, Hampton, Va. 23665
An overview is presented of some of the current needs for spaceborne pollution monitoring. Emphasis is placed on the role of infrared spectroscopy in meeting the remote sensing requirements for determining atmospheric constit- uents from a spaceborne platform. Relevant spectral response data are presented for some commercially available infrared pyroelectric detectors over the range of 2.5 to 14 microns.

NASA RESEARCH TO IMPROVE AIRPORT CAPACITY, AIRWAY EFFICIEN- CY AND FLIGHT SAFETY. Leonard V. Clark.* Terminal Confi- gured Vehicle Program Office, NASA Langley Res. Ctr., Hampton, VA 23665.
Several major airports in the U.S. are presently operat- ing at or near maximum capacity throughout most of the day. Landing and takeoff delays at such airports are costing the air carriers and their customers enormous amounts of money, time, and scarce natural resources (fuel). With the pros- pect for construction of new major airports quite small in the foreseeable future, and with the rapid growth of air travel, especially since recent deregulation, the situation is continuing to worsen. Because of the important contribu- tion that air transportation makes to our national economy, industry and government are working cooperatively to signi- ficantly improve the efficiency of the National Airspace System.
The NASA is engaged in a variety of research with objec- tives to develop and demonstrate improved airborne systems and operational flight procedures which can lead to increas- ed airport capacity, airway efficiency, and flight safety. The Terminal Configured Vehicle(TCV) Program, a focal point for much of this activity, operates a specially configured B-737 airplane as a flying laboratory to conduct its re- search and development with particular emphasis on the ter- minal area environment. The TCV Program is dedicated to providing the flight crew with the advanced airborne systems necessary for it to conduct safe and efficient flight in an increasingly demanding environment.

A METHOD FOR GENERATING MISSION SPECIFICATIONS FOR REMOTE OBSERVATION SPACE PLATFORMS. W. T. Davis* and L. S. Keafer*. NASA, Langley Research Center, Hampton, Va. 23665

As part of NASA's space system research, several studies of large space platforms have been conducted recently. Platforms, as opposed to conventional satellites, can provide opportunities for synergistic application of several large experiments. Determining the proper experiment/ instrument manifest and the associated orbital parameters, e.g., defining the mission specification, are difficult problems involving the matching of knowledge or information requirements to measurement techniques and capabilities for the various space operational modes. The approaches to mission specification used in the various platform studies are described briefly, as well as a new approach to the development of an interactive computer-aided technique. This unique capability can be an effective tool for study of future spacecraft concepts. The application of this technique as an approach to the development of mission specifications for a circa 1995 data acquisition platform for Earth resources and environmental information is described.

SF$_6$ CONDENSATION IN SUPERSONIC NOZZLE EXPANSIONS. S. S. Fisher, School of Engineering and Applied Science, University of Virginia, Charlottesville, Va. 22901.

The condensation of SF$_6$ in a dilute mixture with either Ar or He when expanded through a small, adjustable nozzle has been investigated. Condensation is observed by monitoring the disappearance of individual rotational-state lines in the infrared absorption band of SF$_6$ at 16μm. A diode laser spectroscopy system is used for this purpose. Condensation onset is studied as a function of local temperature, expansion rate, and SF$_6$ concentration. A simple, newly developed kinetic model is used to interpret and correlate the data.

COMPUTER SIMULATION OF LIQUID DROPLET FORMATION AND GROWTH IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL. R. M. Hall, Aeronautical Res. Scientist, NASA Langley Res. Ctr., Hampton, Va 23665

The onset of condensation effects in the Langley 0.3-meter transonic cryogenic tunnel has been linked to the presence of liquid nitrogen seed droplets in the flow. These droplets originate at the liquid nitrogen injection station in the tunnel and evaporate as they are carried around the tunnel circuit. At some temperature approaching the saturation temperature, however, the droplets will not be able to completely evaporate by the time they are swept into the test section. The present talk describes the efforts at Langley to develop a computer program to model the injection process involving the breakup of the injected liquid nitrogen into droplets, the evaporation of the droplets during their transit time to the test section, and the condensation produced in the test section as a result of the surviving droplets. The results of the computer program are then compared to wind tunnel data and conclusions are drawn.

MEASUREMENTS IN A WAKE BOUNDARY LAYER INTERACTION FLOW FIELD AT MACH 6. Floyd G. Howard*, Aerospace Engineer, NASA Langley Res. Ctr., Hampton, VA 23665.

One major obstacle to the development of advanced computational aerodynamic design tools is inadequate turbulence modeling for complicated viscous flows. Improved modeling requires precise three-dimensional fluctuating and mean measurements which are of questionable accuracy when obtained with conventional techniques (i.e., hot-wire, pitot and static probes, etc.). A program is currently underway at Langley Research Center to develop a Laser Doppler and Raman Scattering flow measuring system to obtain the type of data required for these improved turbulence modeling considerations. Since definitive results from this measuring technique are still at least a year or two away, traditional types of flow field measurements are being conducted in complex flows to provide data useful for checking the mean Laser Doppler Velocimeter data as well as for testing current computational fluid dynamic tools.

The present paper discusses results of one such experimental investigation in a complicated hypersonic viscous flow field. Surface and flow field characteristics measured downstream of a cylindrical wake generator positioned normal to and attached to a flat plate will be presented and discussed in detail with emphasis on the development of the turbulent shear layer downstream of the generator.

EXPERIMENTAL STUDY OF DELTA WING LEADING-EDGE DEVICES FOR DRAG REDUCTION AT HIGH LIFT.

D. M. Rao*, Research Professor and T. D. Johnson, Jr.*, Graduate Student, Mechanical Engineering and Mechanics Department, Old Dominion University, Norfolk, Va.

Supersonic aircraft with highly swept wings suffer large drag increment in low speed, high angle-of-attack flight due to flow separation at the leading edges. Control of leading-edge separation would permit higher lift coefficients for a given engine thrust, resulting in improved low-speed performance.

Various leading-edge devices (viz. fences, under-wing vortex generators, sharp extension plates, and open slots) applied to a 60^0 swept delta wing model with rounded leading edges were investigated in the NASA Langley 7-by 10-foot wind tunnel at low speed and up to 28^0 angle of attack. Force and pressure data were acquired along with flow visualization pictures.

All the devices were successful to varying degrees in reducing the drag of the plain wing at higher lift coefficients. The relative merits of the devices and their aerodynamic functioning are examined in terms of the spanwise distribution of leading-edge thrust, supplemented by the flow visualization results. (Supported by NASA Grant NGR 47-003-052).

ANALYTIC STUDY OF A TRUE AIRSPEED INDICATOR. J. Y. C. Shen*, J. M. Kuhlman, and G. L. Goglia. Dept. of Mechanical Engineering and Mechanics, Old Dominion Univ., Norfolk, Va. 23508.

A three-dimensional, inviscid, unsteady, incompressible flow has been studied in a vortex tube by using the hydrodynamical linearized stability theory. Disturbances caused by the sudden enlargement at the rear end of the vortex tube grow exponentially in time, and when amplified to a certain degree give a definite whistle at a frequency which is linearly proportional to the true airpseed.

The objective of this study is two-fold. The first objective is to analyze and design a true airspeed indicator which will replace the conventional pitot-static pressure transducer for small commercial aircraft. The second objective is to obtain a numerical solution to predict the frequency response generated by the vortex whistle indicator at a certain airspeed.

The main advantage of this indicator is that the flow phenomenon, precession of the vortex, which causes the vortex whistle, needs no moving parts. In addition, this indicator should not be affected by temperature, density and humidity changes. (Aided by NASA grant NSG 1177)

AEROSPACE SCIENCE AND TECHNOLOGY IN THE USSR. M. Leroy Spearman*, Aerospace Engineer, High-Speed Aerodynamics Division, NASA Langley Research Center, Hampton, VA 23665.

The USSR considers science and technology as a major constituent to a world revolutionary process of transition from capitalism to communism. Scientific and technological advances are related directly to the economic growth of the state. Accordingly, the USSR shows a great concern for the development of modern education with heavy emphasis on science, technology, and cultural attainments. A review of the educational system is given and some of the technological results, particularly as seen in the emergence of powerful air, land, and sea forces, are highlighted. Some observations are made concerning Soviet design philosophy, some accomplishments, and possible future goals.

FREE-JET DENSITY DISTRIBUTIONS MEASURED BY AN ELECTRON-BEAM-INDUCED FLUORESCENCE TECHNIQUE. P. J. Wantuck* and S. S. Fisher, School of Engineering and Applied Science, University of Virginia, Charlottesville, Va. 22901.

An apparatus has been developed which is used to measure density distributions in free-jet expansions of gases into a vacuum. Densities are measured by passing a beam of high-energy electrons through the jet and recording the fluorescence stimulated in the gas by the passage of this beam. At lower gas densities, this fluorescence is linearly proportional to the density of the gas. This apparatus has been used to investigate both CO_2 and UF_6 expansions. In either case, the large flow rates encountered are pumped cryogenically. These expansions are examined as a function of both nozzle Reynolds number and nozzle geometry. Fluorescence is measured photographically and density distributions are determined by sweeping the electron beam along the jet axis.

EFFECTS OF NOSE BLUNTING ON FLOW PHENOMENA AROUND A JOVIAN ENTRY BODY. S. V. Subramanian*, S. N. Tiwari, Dept. of Mechanical Engineering and Mechanics, Old Dominion Univ., Norfolk, Va. 23508, and K. Sutton*, NASA/Langley Research Center, Hampton, Va. 23665.

The effects of changes in the probe configuration on flow phenomena around a Jovian entry body is investigated. Results were obtained for inviscid radiating shock-layer gas under the assumptions of chemical equilibrium. The initial body shape considered was a 45-degree sphere cone. Different configurations for the forebody of the entry probe were considered to represent the shape change due to ablation. The results indicate that while the nose blunting increases the temperature all along the body surface, its influence on increasing the density is significant only in the stagnation region. This, in turn, results in higher stagnation region and downstream pressures. Uniform mass loss resulting in a shape that corresponds closely to the initial profile does not affect the temperature, density, and pressure distribution along the body appreciably. The shock stand-off distance is found to increase with increasing bluntness of the nose. Severe nose blunting is seen to increase the stagnation region radiative heating of the body. Density and velocity variation along the stagnation stream are not influenced by profile changes. However, in the downstream region, density and velocity variations across the shock layer are altered significantly by the probe configuration changes.

Statistics

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May 8-11, 1979, University of Richmond

ESTIMATING RELATIVE POTENCY FROM THE HYPERBOLIC DOSE-RESPONSE MODEL. J.T. Crowe, Jr., A.H. Robins Co., Richmond, VA 23220.

The fundamental dose-response function for many pharmacological and toxic agents can be derived from the assumptions of Receptor Theory and the Law of Mass Action. This function is the rectangular hyperbola, $y = Y_m d$ $(K+d)$, where y is the response, Y_m the maximum response, d the dose and K is equivalent to the median effective dose (ED50). If two drugs have the same maximum response, an estimator, $R = K_s/K_t$, can be derived which expresses the relative potency of a test drug, T, to a standard, S. This paper presents the derivation and properties of the estimator, R.

APPROXIMATE COMPARISONS OF TWO BINOMIAL POPULATIONS. B. K. Ghosh. Dept. of Mathematics, Lehigh University, Bethlehem, PA 18015, and Dept. of Statistics, VPI&SU, Blacksburg, VA 24061.

Suppose that p_1 and p_2 are the unknown proportions of success in two binomial populations. The following problems arise quite frequently in practical situations: (a) test the hypothesis $p_1 = p_2$ against $p_1 \neq p_2$ at a given level of significance; (b) test $p_1 \leq p_2$ against $p_1 > p_2$ at a given level; and (c) construct a confidence interval for $p_1 - p_2$ with a given confidence coefficient. This paper gives a comparative study of three well-known approximate test procedures for each of (a) and (b). Extensive numerical results are obtained on the type one error probability and power of these tests. The paper also investigates into the adequacy of a well-known approximate confidence interval for the problem in (c).

A COMPARISON OF CERTAIN REGRESSION ESTIMATORS IN THE PRESENCE OF NON-HOMOGENEOUS VARIANCES. M. L. Deaton*, M. R. Reynolds, and R. H. Myers. Dept. of Statistics, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061

The problem of estimation and hypothesis testing for the general linear model with unknown heteroscedastic variances is considered. Ordinary least squares estimators of the regression coefficients are compared with weighted least squares estimators using estimated weights. Empirical results provide sufficient conditions for weighted least squares to have smaller MSE than ordinary least squares estimates.

Alternative estimates for the variance-covariance matrix of the coefficient estimators are compared. First and second moments are provided for some variance estimators. Recommendations for which estimator to use are provided.

The usual test statistics for the general linear hypothesis are shown to deviate from the F- or χ^2-distributions that are often used in practice when using ordinary least squares or when the error variance matrix is known. A good approximation to the distribution of these test statistics is given. (Aided by NASA grant NSG1376)

FACTORIAL EXPERIMENTS WITH POISSON RESPONSE VARIATES. The DISTRIBUTION THEORY FOR EXACT TESTS. A.D. Harris*, Dept. of Math., Va. State Col., Petersburg, VA 23803, W. H. Carter, Dept. of Biostat., Med. Col. of Va., Richmond, VA 23298.

Recent research has indicated that the micronucleus test is a relatively quick and easy way of measuring the carcinogenicity of compounds. Research also supports the assumption that the frequency of micronuclei are Poisson distributed. It, therefore, seems reasonable to suppose that a statistical procedure which would test for interaction in a factorial experiment where the response variates are Poisson could be applied to micronuclei data for the purpose of testing for interaction among potential carcinogens.

Such a procedure is developed based on the conditional distribution of Poisson random variables. The necessary distributions are derived and a method for performing tests on interaction in 2^k factorial experiments with Poisson response variates is described. The tests are based on the exact distribution of the test statistics. A procedure for analyzing fractional factorial experiments is also developed.

A normal approximation to the exact distribution of the test statistic is given. The results of simulation studies to measure the adequacy of the normal approximation under various conditions are presented.

Finally, a formula for computing the power of the normal approximation against specific alternatives is given.

GENERATING MATRICES OF WISHART'S TYPE. D. R. Jensen and Y. V. Hui. Dept. of Statistics, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

Three methods are compared for generating pseudorandom noncentral Wishart matrices. These include a direct method, a modified convolution method, and a block composition method. Applications are noted in assessing the accuracy of approximations to the joint distributions of certain functions of the elements of Wishart matrices, and in constructing multiple tests at level α using Friedman's statistics when their limiting joint distribution depends on parameters of the underlying distribution.

CREDIBLE CONJECTURE OR SCIENTIFIC TRUTH. Marvin A. Kastenbaum*, Ph.D., The Tobacco Inst., 1776 K Street, N.W., Washington, D. C. 20006.

In January 1978 the Food and Drug Administration announced that from April 1978 on, all oral contraceptive labelling would carry a highlighted notice warning users against cigarette smoking. This decision, the FDA alleged, was based on sound scientific and statistical evidence. Nevertheless, several independent, competent statisticians who examined the same evidence found that the FDA conclusions were questionable.

THE MAX VARIANCE RATIO IN EXPLORATORY DATA ANALYSIS, D. V. MATHUSZ, Operations Research Division of USALOGC, Ft. Lee, VA. 23801

Exploratory Data Analysis is investigative in nature and as such, it's procedures involve graphic displays of the structure of data. Selection of these graphic devices are primary tasks for the researcher. To aid in these decisions, a simple index has been designed to measure the amount of clustering at the range extremes or it's opposite, i.e. a center cluster whose range is defined by "outliers." This index is the MAX Variance Ratio (MVR). It is the ratio of the variance of the data devided by the maximum variance possible for "n" data points, free to take any value set over the same range, with the same number of points. This MVR has a normalized scale of zero to unity. The MVR can be divided by a Neutral Variance Ratio (NVR), that defines when the aggregate clustering at the range extremes reverts to the opposite. It is shown that the MAX Variance for even n is $R^2/4$, but that for odd n is $f(R,n)$ which converges asymptotically toward the value for even n, as n increases. It is also shown that in the limit NVR is $1/3$ of $R^2/4$. Tables and graphs are provided for small n not close to the limiting values. The index is demonstrated in a classic example.

THE PROCESS & OUTCOMES OF THE VIRGINIA HEALTH INTERVIEW SURVEY. Frank H. Mays*, Southwest Virginia Health Systems Agency, Blacksburg, Va. 24060

In Sept. 1977, the five hlth. systems agencies (HSAs) and State Health Dept. pooled funds for a statewide hlth. interview survey to obtain detailed information on family hlth. status, life styles, and patterns of use of the hlth. care system among Va. families. Research Triangle Inst. was selected as primary contractor; the Director of Va. Ctr. for Hlth. Stats. served as coordinator; and the Va. Hlth. Interview Council (with the author as Chairman) was formed to direct the project and give final approval to written project reports. A contract specification was for a sample size where data collection and analysis would be provided for five (5) distinct subdomains of an estimated 1000 households each to facilitate comparative analysis among Va. regions and to highlight regional differences. The sample design was primarily in 3 stages, with stratification imposed at 1st stage to control sample distribution with respect to geography, level of urbanization and relative socioeconomic position. OUTCOMES: There was a yield of 5,617 eligible household units to be surveyed; interviews were completed in 5,069 households with an overall response rate of 90.4%. The refusal rate was 4.5%. Statewide estimates can now be made on variety of health status and use measures with a coefficient of variation (CV) generally less than 10%. Health care planners now have a data set on families which represents a significant contribution to knowledge.

SIGNAL CLASSIFICATION BASED ON EMPIRICAL DISTRIBUTIONS OF ZERO CROSSINGS. James R. Schiess*, NASA, Langley Research Center, Hampton, VA 23665.

In the absence of a non-zero waveform, digital signals are zero mean random error. For this reason the number of times the recorded signal crosses the zero axis is related to the presence of a signal. Probability distributions are fit to crossing counts over subintervals of the signal and used in Bayes' theorem to derive a classification rule. The method is applied to EEG data to show the usefulness of this approach.
*Member, ASA

DECISION CONSIDERATIONS FOR COMBINATION CHEMOTHERAPY SURVIVAL EXPERIMENTS. Donald M. Stablein, Walter H. Carter, Jr., Dept. of Biostatistics, Med. Col. of Va., Richmond, VA 23298, G. L. Wampler, Dept. of Medicine, Richmond, VA 23298

The proportional hazard model provides a potentially useful procedure for the analysis of combination chemotherpay animal survival experiments. The design considerations for such experiments are complicated by the fact that maximum likelihood estimation of model parameters does not yield estimators in a closed form. Therefore, it is not possible to study their properties analytically. A simulation study has been undertaken to arrive at design criteria under the assumption of a relative hazard that is quadratic in the drug dosages administered. Different designs are evaluated with respect to their ability to locate the optimum and its associated response, as well as the variance and bias of the parameter estimates. Some interesting effects of singly censored data results.

ANALYSIS OF A NON-PROPORTIONAL HAZARD MODEL. Donald M.
Stablein, Walter H. Carter, Jr., Dept. of Biostatistics,
Med. Col. of Va., Richmond, VA 23298, G. L. Wampler,
Dept. of Medicine, Richmond, VA 23298

The concern that hazard functions in cancer chemothera-
peutic situations may not be proportional motivates the
development of a non-proportional hazard model. Subsequent
to its construction, the regression analysis of experimental
data permits the application of response surface techniques.
After the estimation of the underlying hazard function, the
quality of the fit of the model is assessed. Further treat-
ment levels may be optimized and estimated survival dis-
tributions plotted for any treatment combination. In an
example of two drug treatment of murine L1210 leukemia,
statistically significant non-proportionality is determined.
Analysis permits extraction of potentially important infor-
mation on drug inter-relationships which has been previously
unavailable.

MODIFIED PRINCIPAL COMPONENTS REGRESSION: A MEAN SQUARED
ERROR EVALUATION. H. T. Wu and J. W. White. Dept. of Statis-
tics, Va. Polytechnic Institute & State Univ., Blacksburg,
Va. 24061

When Principal Components Regression is used as an alter-
native to Least Squares in the presence of a near singular
X'X matrix its performance depends strongly on the orienta-
tion of the deleted components to β, the vector of unknown
regression coefficients. In this paper we present a modi-
fication of the Principal Components Procedure in which com-
ponents associated with near singularities are dampened but
are not completely deleted.

The resulting estimator was compared in a Monte Carlo
study with Least Squares and Principal Components using Mean
Squared Error as the basis of comparison. The results indi-
cate that the modified estimator will perform better than
either of the other two estimators over a wide range of
orientations and signal-to-noise ratios and that it provides
a reasonable compromise choice when the orientation is un-
known.

THE APPLICATION OF RELIABILITY THEORY IN BIOSTATISTICAL
STUDIES. S. Zacks, Department of Mathematics and
Statistics, Case Western Reserve University, Cleveland,
Ohio 44106

Reliability theory embraces various branches of proba-
bility and statistics applied towards the modeling,
analysis of the structure and the inference of the survival
probabilities of complex systems. Traditionally, relia-
bility theory has been oriented toward engineering systems.
Applications in biostatistical studies address similar
problems on biological systems. In the present paper we
focus attention on three areas of applications in bio-
statistics:

    (i)   Survival functions and remaining life distribu-
           tions of patients;

    (ii) Tolerance distributions and the determination of
           optimal dosages;

    (iii) The problem of "safety-dosages".

VIRGINIA JOURNAL OF SCIENCE
OFFICIAL PUBLICATION OF THE VIRGINIA ACADEMY OF SCIENCE

THE VIRGINIA JOURNAL OF SCIENCE

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All manuscripts and correspondence about them should be addressed to the **Editor.** The Virginia Journal of Science welcomes for consideration original articles and short notes in the various disciplines of engineering and science. Cross-discriplinary papers dealing with advancements in science and technology and the impact of these on man and society are particularly welcome. Submission of an article implies that the article has not been published elsewhere while under consideration by the Journal.

The original and two copies of each manuscript and of all figures therein are required. *Authors should submit names of three potential reviewers.* All articles should be typewritten, double-spaced throughout, on one side of good bond paper (8½ × 11 inches). Margins should be not less than 1¼ inches on any border. Each manuscript should be complete and final when submitted. It should include the title, author's name and

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The VJS reserves the right to make page changes for very long manuscripts, and to bill the authors at cost for unusually extensive complicated illustrative material or extraordinary alterations in the text in proof.

VIRGINIA JOURNAL OF SCIENCE
OFFICIAL PUBLICATION OF THE VIRGINIA ACADEMY OF SCIENCE

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EDITORIAL

The Editor and Business Manager of the Virginia Journal of Science were instructed by the Publications Committee of the Virginia Academy of Science to combine under one cover the last two issues of Volume 30 (1979) of the Journal, so that the effort to get the Journal back on schedule could be speeded up. Thus, this printing of the Journal is counted as combined Fall and Winter issues. The publications committee also strongly advised that this policy be continued into Volume 31 (1980), and we intend to follow their advice. Thus, the next printing will be Volume 31, Issues 1 and 2, under a single cover. Issue 3 of 1980 will be the Proceedings issue, which should place the Journal back on schedule.

The Editor wishes to express his appreciation to the Publications Committee, the Council and the Executive Committee of the Academy for patience and support during the year-long transition period between editors, and especially to former President Dale Ulrich, whose moral support has been unfailing.

Business Manager Kizer has labored long and hard to attract advertising, and the Editor urges all business members and readers who are officers of businesses to respond heartily to Mr. Kizer's efforts.

Members should remember the journal welcomes submitted manuscripts. A good journal must have good papers. Please help us by sending more of those good manuscripts we need.

The Commonwealth - Science Education and Technology
The Sidney S. Negus Memorial Symposium

Fifty-Seventh Annual Meeting of the Virginia Academy of Science

May 10, 1979
Camp Theatre, University of Richmond

Participants:

Dr. E. Bruce Heilman, *President, University of Richmond*
Moderator

The Honorable Maurice B. Rowe, *Secretary of Commerce and Resources, Commonwealth of Virginia*
The Role of State Government in Science and Technology and the Role of Science and Technology in State Government

Dr. W. E. Campbell, *Superintendent of Public Instruction, Commonwealth of Virginia*
The Role of Elementary and Secondary Education

Dr. Frank L. Hereford, Jr., *President, University of Virginia*
The Role of Higher Education - Undergraduate and Graduate

Dr. Helmut R. R. Wakeham - *Vice-President for Science and Technology, Philip Morris, Inc.*
Industry - Its Needs and Expectations

The Role of State Government in Science and Technology and the Role of Science and Technology in State Government

The Honorable Maurice B. Rowe

Secretary of Commerce and Resources
Commonwealth of Virginia

In recent decades we have come to realize the ever increasing importance of science and technology in solving critical problems and in enhancing our quality of life. (The mid-sixties saw the manned moon landing as the symbol of technological achievement, and in the field of social problems, the federal great society programs were a similar massive effort.)

In the early seventies, environmental health and ecological problems gained increasing significance, in part as the result of improved environmental monitoring techniques. Emerging from this convergence of events was a renewed belief on the part of many government officials and others that science and technology would have a significant role in developing solutions to social and environmental problems, particularly those faced by state and local governments.

In Virginia state government has recognized the value of science and technology in defining problems and evaluating possible solutions. State agencies across each area of cabinet responsibility have developed and implemented programs based on the application of science and technology, much of which has been provided by institutions of higher education.

· Within the Office of Commerce and Resources, agencies such as the State Water Control Board, Marine Resources Commission, Department of Conservation and Economic Development, and the State Air Pollution Control Board are involved daily in both monitoring the quality of our air, water, and land resources and in managing the use of these resources.

Basic and applied research conducted by the institutions represented by many of the members of this academy is utilized by government and private industry on a daily basis in making resource management and business decisions.

Technology of benefit to state agencies and by local governments in satellite imagery of the earth, one of the most important practical application systems to emerge from the space program. Landsat, as this system is known, offers information of board economic

and environmental value through its ability to produce repetitive images of changing earth conditions. Landsat images can inventory watershed conditions, identify air and water pollutants, study urban growth patterns and detect agriculture problems.

Often the knowledge of data available from Landsat and more conventional sources of information are unknown to potential users. To deal with this problem, the Commonwealth is developing the Virginia Resource Information System as a means for integrating information from various sources for easy access to support analysis, evaluation and management decisions related to air, land, water, agricultural, and forest resources. When implemented this information system will offer many benefits to state agencies, academic insitutions, and other interested potential users in Virginia. These benefits include:

   a. The provision of a single point of contact for statewide resource information without interfering with current data gathering activities, and
   b. The provision of a mechanism for assembling data from a variety of resources focused on a particular political, geographic or planning district boundary.

There are indeed many other examples of valuable technology transfer contributed by education and research institutions of our Commonwealth. In fact there is daily exchange of information by our science and technology community with program specialists of state government.

With due consideration of progress, the utilization of science and technology in government decision-making and policy-formulation process must be increased and refined. Since the late 1960's there have been formal and informal attempts to improve the communication between Virginia state government and the science, engineering, and technology community through the appointment of a Governor's Science Advisor and more recently through closer ties with the Virginia Academy of Science. Some of you are aware that the Commonwealth recently prepared a study sponsored by the National Science Foundation to analyze the state's decision making needs for further science, engineering and technology expertise and to devise a plan for responding to these needs. In late 1977 the division of legislative services and the department of intergovernmental affairs began studies for the legislative and executive branches, respectively. The results of the executive branch study reveal that there is a perceived need on the part of most members of the cabinet and in many state agencies for a central coordinative mechanism which would help decision-makers to identify sources of knowledge with specific expertise. There was a concensus that such a system should be flexible and serve primarily as a communication network. This will assist decision-makers in assessing options available for the resolution of policy issues and will assist the agencies in identifying applications of research knowledge to particular problems.

I am pleased to report the following initiatives on the part of the executive branch:

   1. The Department of Planning and Budget will be vested with responsibility for activating the science advisory mechanism.
   2. An existing position within the department will be assigned responsibility for the coordinative aspects of science and technology advice.
   3. The department's efforts for the next several months will be, in essence, picking up where the study left off in such areas as:
      a. Identifying resources/expertise available.
      b. Developing an evaluation device to test the mechanism.
      c. Testing the mechanism for validity refinement.

In exploring the ways for taking the fullest advantage of the relationship between science and technology and state government, we must be creative and innovative. The focus of this effort should not be to develop and foster the utilization of particular "solutions"—technologies, techniques or systems. Instead, we should work toward building the analytic and evaluative capabilities of state government. We must be careful of the temptation to institute attractive programs which promise to promote short-run, highly visible results. In short what matters is not only the adoption of an innovation, but how that innovation is used and how its adoption and use are linked to the satisfaction of a need or solution of a problem.

The Virginia Academy of Science has been effective and important organization for interfacing the scientific community with policy decisionmakers and advancing the interest and requirements for persons educated as professionals in the broad area of the sciences.

May I call upon you to continue to exert leadership to provide educational opportunities to enhance the professionalism for scientists and become more active in the mainstream of our society and economy to objectively mold public opinion.

The conditions prevailing today across our nation cause us to be very conscious of the tremendous need for scientific evaluation and for scientists to step forward and speak with authority.

We are much more conscious of risks which we encounter daily than people were 50 or even 25 years ago. This is not only because we are better educated, but also because news media brings to our attention much more information than was conceivable in former years. We really ought to be given an opportunity to compare the different risks around us before being put into a panic by those who lack scientific knowledge to speak with authority.

I would like to thank the Academy for its learned and valuable counsel, particularly most recently in the development of the National Science Foundation report. I urge you to assist in fostering closer ties between the scientific community and state government toward developing a more informed base for policy formulation in the executive and legislative branches.

The Role of Elementary and Secondary Education
(Outline of Comments)

Dr. W. E. Campbell

Superintendent of Public Instruction
Commonwealth of Virginia

Concerns and Problems

I. Lack of scientific literacy on the part of too many of our citizens, including students and graduates.
  A. Uninformed and not able to deal effectively with too many day to day decisions.
    1. Should I use a hair dryer? (Asbestos)
    2. Are the fish in the James River safe to eat? (Kepone)
    3. How dangerous are chemicals in our schools? (Picric acid)
    4. Should I favor nuclear power generation? (Three Mile Island)
  B. Not able to distinguish between scientific evidence and personal opinion.
    1. With Crest I will get fewer cavities!
    2. Smoking won't affect my health!
    3. If I drive 70 miles per hour I get there faster and save gasoline!
    4. Modifications of weather produce only positive results!
  C. Unmotivated to increase scientific knowledge throughout life.
    1. Lawyers have no need for scientific information.
    2. Just ask the "experts."
    3. Scientific facts are not subject to change.

II. Much improvement needed to teach science more effectively.
  A. Recent NSF study showed:
    1. Only 4% of classes in elementary science taught in special science rooms.
    2. More than one-third of instruction is done without special science equipment.
    3. In the secondary schools lecture and reading about science are most prevalent means of instruction.
  B. Most students not drawn into science even in a nontechnical way.
    1. Fifty percent of the students take no science courses beyond tenth grade.
    2. Decline in students taking so-called "hard" subjects.
  C. Many teachers are, or feel they are not well prepared to teach science, especially in elementary school.
  D. Field trips and laboratory work not considered an essential part of the science program.

E. "Back to Basics" has cut into the time for science and other subjects.

III. A Decline in Achievement
  A. Achievement of 17 year olds has continued to drop through all assessments in science since 1969.
  B. Appears to be a declining interest in and knowledge of science by nation's school children.
  C. Steep decline in physical-science achievement.
  D. SRA test scores have declined for eleventh graders in Virginia since 1970.
  E. Lower socio-economic levels, females and residents of large cities tend to perform below national averages at fourth, eighth, and eleventh-grade levels in science achievement.

IV. General Areas of Concern
  A. Environmental-energy problems brought on due to lack of basic scientific knowledge.
    1. Lack of understanding about the interactions and inter-relationships of the physical and biological world.
    2. Lack of realization that high energy level economy demands trade offs for favorable environment.
    3. Lack of basic understanding of the finite nature of fossil fuels.
  B. Failure to view science as a "basic" in this scientific-technological society.
    1. Science not viewed as a logical subject to teach knowledge application and transfer.
    2. Failure to view science as important component in the students' program can lead to future decline in technology.
    3. Subjects such as science can emphasize the "basics" (reading - arithmetic) by creating interest for many students.
  C. Many science programs not relevant for general student population.
    1. Emphasis on dissection of the earthworm rather than subject of ecology.
    2. Over emphasis of *second* level programs rather than emphasizing such *first* level programs.
    3. Too little emphasis on programs for the non-science oriented student.

What Virginia is Doing

I. Through Science Community Network developing better communications among Department of Education, colleges-universities, and local school divisions in order to develop statewide goals-objectives for science and work collectively to achieve these self-objectives.
1. Stresses articulation K-12.
2. Content of science focusing upon energy-environmental concerns.

Publications stress laboratory-field studies with emphasis upon the inquiry approval.

Taking a very serious look at requiring another year of science for meeting graduation requirements.

II. Continue to emphasize science as a method of inquiring about the world rather than as a set of conclusions about it.

Requires special science rooms, special supplies and equipment and field experiences to be most beneficial.

Requires teachers who will use their special rooms, supplies and equipment and encourage students to probe for answers.

Requires teachers well trained in their subject matter and well trained to work with students in a manner that will help students understand.

Requires approaches that will encourage students to want to become involved in learning more about science.

State requirement that science be taught as a laboratory program, whereas some neighboring states are not.

Advises local school officials with regard to desirable types of science facilities. Science personnel of State Department reviews plans. Suppliers say Virginia still building laboratories.

Selects textbooks that reflect a more difficult approach to learning science.

Recent publications by the Department which stress laboratories and field trip experiences for students.

Required endorsements for all areas of science teachers.

Conduct workshops for teachers which stress laboratory and field trip experiences for students.

III. A Better Assessment of What Achievement Scores Mean

Find answers to such questions:

Are the scores measuring what is currently being taught?

Are the test scores reflecting something other than science content?

Is the 17-year decline in achievement due to fact that fewer students are taking more than one year of science?

Are science programs relevant for the non-science oriented student?

Through the Science Communication Network to encourage local school divisions to urge students to take more than the required course in science.

About six divisions require two units. Fairfax and others are studying the matter.

In Summary

1. Development of Program Goals and objectives for science K-12.
2. Production of publications which stress science as inquiry.
3. Empahsis upon training and having more qualified teachers.

In this time of surplus in the teacher market more emphasis can and should be placed on assigning teachers to subject areas and student levels in which they are most qualified.

More coordination with the colleges and universities for preparation and continuous growth of science teachers.

4. Subject matter of science must be relevant for all levels of students, including greater emphasis on science education for the general students.
5. Encouraging earth science and environmental-energy types of courses, and middle school science program.

The Role of Higher Education - Undergraduate and Graduate

Dr. Frank L. Hereford, Jr.

President
University of Virginia

I am delighted to be with you this evening and to have the opportunity to comment on the role of higher education in science education and technology.

The first point I should like to make is that the role of higher education in science and technology is no different from its role in any other branch of knowledge. Actually, there are two roles—the dissemination of the existing body of knowledge and the gaining of new knowledge through research. It is generally recognized that colleges and universities also have a public service responsibility beyond teaching and research, but I believe that their concern with knowledge is and should be paramount.

There is a tendency to consider science and technology as different from other branches of knowledge, because applications of scientific knowledge so obviously translate into technology resulting in improvements in food production, medical care, radio and telecommunications, and in other areas which enhance the quality of life. However, this is true of every field of knowledge. Surely the human mind has exerted the most powerful single influence on the advance of civilization. But what would man's intellectual power be without the understanding of the past provided by scholars of history; or of political science, economics, and social systems provided by scholars in the social sciences; or of human values provide by scholars in the Humanities? There is a tendency to believe that new scientific knowledge gained through basic research has a more immediate impact on civilization, but I dispute this also. Radio and telecommunications today have derived in a continuing way from the research of James Clerk Maxwell, a British professor of physics, and other physicists in the mid-1800s—a century and a half have transpired.

Richard Feynman, the Nobel Prize-winning physicist, provided an interesting example some years ago of the media's tendency to over-emphasize the immediate application of scientific knowledge. New convincing evidence had been found of a rapid turnover of matter in the brain—the actual replacement of old atoms by new ones. Feynman's own words exhibit his flair and humor:

> What is this mind, what are these atoms which have consciousness? Last week's potatoes! *That* is what now can remember what was going on in our mind a year ago—a mind which has long ago been replaced.

The headline of a news story on this discovery had stated "New Hope for the Cure of Brain Cancer"—

obviously a premature expectation. Feynman, however, sought to convey as I do now, simply the intriguing nature of the remarkable fact that our ongoing consciousness and the storage capacity of our brains reside not in some stable, unchanging piece of matter—such as a computer—but in some stable mode of biological interaction between transient bits of matter in the brain.

What good is this knowledge? What good is a History—or a sonnet? Each is simply an example of man's effort to understand the nature of the universe and to express his perception of his role in it. Surely this ongoing effort and man's excitement over it and dedication to it are the most distinctive characteristics of the human race.

These remarks bring into focus the particular role of higher education—as distinct from that of government or industry—which I believe does and should exist. Again its particular role is the gaining of knowledge and its dissemination—as distinct from putting it to use and applying it for the benefit of people or for the enhancement of our economic prosperity—which, of course, also benefits people.

However, this principal role is not absolutely exclusive. There is no sharp dividing line between pure knowledge and its application. Our universities do engage significantly in the use of new knowledge. Our professors of medicine seek new cures for disease when an understanding of the disease renders this feasible; our schools of engineering are committed to applied research; and the work of scholars in the social sciences and humanities helps society to make the best judgments on the priorities to be assigned to emerging technologies.

However, I believe that examination of these efforts will show that they are more at a level of understanding new knowledge than at a level of actually producing a new computer or mousetrap for the market. Certainly no faculty member would be distressed if a patentable idea or device emerged from his work, but I don't think that this would be cited as a primary motivation.

From the point of view of the general public, I suppose the most readily apparent contribution which higher education makes to science and technology is the production of highly trained and educated young men and women to continue the quest for knowledge and to put it to work for mankind. Let there be no doubt our our commitment to that task, but the teaching function of colleges and universities goes hand in hand with research. I cannot recall a faculty member who was able to sustain good teaching over a period of

years without remaining a student himself—and a researcher is a student. His investigative work gives him new insights, and keeps him excited. Whether teaching undergraduates or graduate students it is vir- tually impossible for a teacher to intrigue and excite students about a subject unless he himself is intrigued and excited. Futhermore, the students play a role by provoking a continuing reexamination of ideas and concepts on the part of an instructor. I have often heard physicists in our national laboratories such as Oak Ridge or Los Alamos say, "You have a great advantage over us; you have students."

In carrying out its role higher education by no means operates in a vacuum. It interacts strongly— more strongly than at any time in the past—with the federal government, it interacts with state and local governments, with industry, and this day and time with public interest groups. Although none of these interac- tions is problem-free, I believe the most serious prob- lems today are in the area of university relations with the federal government, and I shall use my remaining time to comment on them.

The contract between society and academy actually originated many years ago in Europe, where society recognized the value of the modern university and gave its support to the learned professions because learning was intrinsically good. In our own nation the federal government was brought into the contract through legislative actions beginning with the Morrill Act. However, large scale federal involvement began fol- lowing World War II with the National Science Foun- dation, the National Endowment for the Humanities, the National Institutes of Health, and other agencies.

From the end of the war until about ten years ago the contractual agreement evolved satisfactorily, but now there are signs that it is faltering. Brewster C. Denny, dean of the Graduate School of Public Affairs at the University of Washington described this situa- tion well several months ago in an editorial in the journal *Science.*

> ... the old bargain is coming unstuck,
> largely because of the success of the
> American additions to the original Euro-
> pean contract. Higher education, like
> government and health care, has become
> big business, and the general distrust of
> large institutions has reached the cam-
> pus as well. The signs of deterioration of
> support and erosion of the contract are
> visible to all: the steady decline in sup-
> port of the premier research and teach-
> ing institutions ... the end of low or even
> free tuition in public institutions; severe
> budget problems in private colleges and
> universities; the declining use of merit
> pay for faculty; increasing government
> disincentives to philanthropic support
> of the arts and education; the attack on

peer review; politicization of boards of regents in public institutions; direct intru- sion into university decisions by federal, state, and local government; and efforts to make university endowments and properties subject to direct political con- trol.

I agree with Dean Denny that we need to negotiate a new contract, one that includes, as a national policy, recognition of our system of higher education as a vital national resource. Government support of universities should be considered an investment in the future of our civilization, rather than the purchase of research from a vendor. The largest reasonable degree of autonomy for institutions of higher education should be pro- vided, because their contribution to society depends on it. They need stable support rather than "roller coas- ter" support under which they have been periodically called upon to help during the sputnik era or in solving the environmental crisis or the energy crisis.

To justify the public confidence which all of this will require, higher education must make a new commit- ment to accountability, to performance, and to a wil- lingness to communicate to the public what it is doing and why. Anyone left in the ivory tower should descend.

I am glad to be able to report to you that in my judgement the negotiation of a new contract has begun—at least to the extent that a willingness to discuss our problems seriously has emerged among both government and higher education leaders. I can- not remember a time when more university presidents have met with more federal officials for this purpose than during the past year. I have participated along with other university presidents in many of these meet- ings with cabinet secretaries, undersecretaries, the White House Science Adviser, and heads of federal agencies; and a convincing commitment on both sides to resolve our problems is very apparent.

Moreover, concrete steps have been taken. Under the auspices of the Association of American Universi- ties a National Commission on Research has been established to devise a comprehensive overhaul of the now cumbersome and bureaucratic procedures under which federal grants and contracts to universities are administered. On the federal side the President has begun fulfillment of his campaign pledge to diminish and disentangle the federal regulatory machine, and his recommended budget—if adopted—will end a ten- year slump in federal support of academic research. In a message to Congress on March 27, the President outlined a commendable federal science support pol- icy. I hope that the Congress will respond positively. A beginning has been made, and our institutions of higher education must work strenuously and diligently for the success of this endeavor which is so important to our prosperity and welfare.

Industry - It's Needs and Expectations

Dr. Helmut R. R. Wakeham

Vice-President for Science and Technology
Philip Morris, Inc.

Ladies and Gentlemen:

This hour is late and I know that the span of attention for after dinner remarks is short. So I will be brief in expressing the view of one industrialist on the needs of industry from science education.

This position of "bringing up the rear" is very familiar to me because I had the fortune to be born with a name beginning with "W." This has not always been a disadvantage. Being in the rear I have sometimes had a better perspective of what is up front. So let me start with a few definitions.

If you ask the person on the street "Hey, what is science?" you will get answers like "Science is environmental pollution," "Science is television," "Science is computer, Venus probes, lasers."These are popular conceptions. But they are misleading. As we in the Virginia Academy of Sciences all know, science is systematized knowledge, attained through study or practice. Science is thought. The popular mind confuses material things with thought.

Scientific thought requires an act of faith on the part of the scientist. In fact, three acts are required. Act 1. The belief that we are in an orderly universe. Act 2. That by study human beings can understand that order. Act 3. The belief that it is good to have such understanding.

I believe there is order in the universe and I believe we can discern that order. Is it good to understand the order? Well, it's got to be good, otherwise I have to believe in the opposite that understanding is not good and say that ignorance is bliss. And I don't think any of you in this room is prepared to say that. But isn't it fantastic that in this day and age we are told there are some areas of knowing which should be forbidden fruits, that some knowing is evil.

Not long ago people were asked to vote yea or nea on DNA. We have witnessed a city council and mayor argue whether or not scientists should be allowed to do research on DNA recombination. Is it good or evil to know? What do you think when you hear DNA? Most people will think Frankenstein or Andromeda Strain. How many of them will tell you it's the beginning of a brighter and better way of life? Perhaps mutant children who lack some enzyme can literally be made whole. Perhaps we will have disease resistant plants and animals to feed the world.

Such is the intersection of knowing and applying that I foresee. Industry is at that intersection of knowing and applying. And this brings us to another key word of our evening: technology.

People commonly interchange the terms "technol-

ogy" and "science." Technology like science is also thought. It is the method or procedure (not the act) for applying basic scientific knowledge to a practical result. These results often present us with dichotomies such as reactors and bombs, automobiles and pollutants, television and behavior control. These are some of the terms of technology. They lead us into the question of fundamental moral judgments concerning how the knowledge of our universe is to be used. That is in the realm of ethics. Science tells us what is. Ethics tells us what ought to be.

The ethical fad of the day is absolute safety. Of course, there is no such thing as a risk-free society. Even a virtuous life has its risk, as illustrated by the Chinese proverb: "The couple who go to bed early to save candles end up with twins." Nevertheless, the Naderite interventionists, the Congress, and lately even the courts are reflecting citizenry expectations of safety. We have a host of regulatory agencies carrying out with religious zealotry the mandates of Congress for consumer protection. Nearly always the whipping boy is industry which is expected to produce only perfect, idiot proof products. This despite the findings that 75 percent of accidents and mishaps are caused by human factors. Recent examples are the Three Mile Island nuclear power plant mishap and the 727 crash in San Diego.

The cost of protection is enormous—not only the costs of safeguards and recalls, but also the social costs of operating the regulatory agencies. Ultimately the consumer pays in the prices of services or products the added charges of safety. Whether he wants or needs the new layer of protection, the man of common sense must pay to make things safe for the village idiot. Society experiences another loss of freedom which hurts more people than it helps. Most disadvantaged will be the poor who will find less on the market that they can afford.

The resolution of these problems can only be brought about by understanding. Ignorance leads to uncertainty, anxiety and fear. Understanding comes from knowledge. Chemophobia, fumophobia, defectophobia, nuclearphobia arise largely through lack of perspective of what is known and through extreme extrapolation from unknown to fear and on to hopeless panic. Very few protesters are really knowledgeable. Most are cought up in a mass hysteria fed by power hungry zealots. Even the media are guilty. Instead of bringing about understanding and perspective and rational assessment they favor sensationalism by shouting panic buzz words like "poisonous chemicals,"

"toxic fumes," and "radiation damage." Much less frequently do they give out factional information about probabilities, relative concentrations, and bene- fits. Many want to be heros by letting us all know "the sky is falling."

Industry, producing goods and services under the free enterprise system, has brought about the highest standard of living in the world. People in developing countries yearn for better life and try to emulate our system. Our Virginia prosperity stems from at least three hundred major industrial organizations based on scientific and technological knowledge. They only exist because they are able to recover some financial return on the financial investment they have made in technical applications. Such applications only come about through the diligent and honest efforts of Virgi- nians. And yet, many consider the return immoral because it is called "profit." They overlook the fact that everyone who survives—the teacher, the government worker, the factory manager, the farmer, and even the welfare recipient "profits" in some way or other from his effort.

Most industries these days depend in one way or another on the applications of science and technology. But more importantly they depend on people. Edu- cated people. People who can learn to operate the complex technological systems introduced to increase worker productivity and to make possible greater rewards. People who can understand cause and effect, risk and benefit, chance and probability, profit and loss. People who can communicate effectively and efficiently.

As our society expands and develops in complex- ity, instead of finding more and more people with these qualities, we find fewer of them. Not that our high schools, colleges, and universities have fewer students. It is just that fewer of them seem to be qualified to bcome productive in industrial systems. Several aspects of this problem deserve elaboration.

In the first place, many potential employees lack basic skills in, for example, the three R's. Many gradu- ates fail simple reading and writing requirements. The recent publication of a test for mathematical skills required of high school graduates was to many of us a depressing revelation of how schooling standards have changed. And why not? Who wants to learn multipli- cation tables when pocket computers are handy? But do mental skills improve with pocket calculations?

A second problem for industry is that proportion- ally fewer students are going into the engineering, mathematical, and physical sciences than before. This situation stems partly from the belief that the problems of the world are brought about by the applications of science and technology. There is now developing a very serious shortage of qualified scientists and engineers which will be with us for at least a decade. Further- more, more graduates are attracted to secure govern- mental and institutional positions than to industry where disciplines and performance demands are more apt to be applied.

Both technical and liberal arts graduates usually require a long time to adjust to the business environ- ment in industry. They are inexperienced in employing their skills for business purposes. They are often unfa- miliar, and sometimes even opposed, to the free enter- prise capitalistic system. They have little concepts of budgets, cost control, resource management, profit and loss, or how to use their time efficiently.

Let me illustrate with an example familiar to me. Philip Morris tobacco operations in 1967 employed 79 persons to make a unit of product. Through automa- tion and the introduction of high-speed, electronically- controlled machinery and extensive use of computers this number is now 59, and by 1981 it will be down to 52. The resulting increases in productivity enable us to provide increased pay and benefits to our work force and to keep up with our growing business. The people operating and servicing these new machines require extensive training, not only in the specialized technical skills required, but also, in many instances, in basic verbal and mathematical skills because new hirings lack these skills. This is true now only for factory operators but also for supervisors. For this reason, Philip Morris has extensive training facilities and training personnel for all levels of employee. Our Richmond training budget alone is over 6 million dollars.

Industry needs courageous, intelligent, educated, and trained people who are dedicated to excellence and achievement; and who, at the same time, recognize the interactions in our complex society and the need for trade-offs to make things work. Knowledge and under- standing are fundamental to progress. We depend to a great extent on our educational institutions to provide us people with these qualities.

Statewide Survey of Psychology Majors in Virginia: Class of 1978

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During its May 1978 Business Meeting the Psychology Section of the Virginia Academy of Science approved a plan to conduct a survey of all Virginia college and university psychology graduates receiving a degree in 1978. The survey's plan was to invite all academic departments or divisions to send the 1978 graduates a copy of the follow-up survey questionnaire, developed by the Southern Regional Education Board, under cover of a letter from the department chairman or other faculty member likely to be best known to the graduates. A copy of the questionnaire is available on request to the author. This paper is a summary of the results of the survey.

Twenty private and thirteen public institutions listed by the state's Council of Higher Education as having degree programs in psychology were invited to participate. All but two institutions accepted. Ferrum College declined because it was erroneously listed and did not offer a psychology major. Liberty Baptist College declined because it had not been in operation long enough to develop adequate alumni address files. Each of the 31 institutions which agreed to participate was provided with sufficient questionnaire copies for a original mailing plus a (50% anticipated) second mailing to those not responding within a month's time of the November 1978 recommended mailing period. It was also recommended that responses received by the departments be sent to us by the end of January 1979 so that the data could be processed in large batches.

Of the 31 institutions which had agreed to participate 19 actually sent in completed questionnaires—7 of the 13 public institutions and 12 private institutions. Hence, this report is based on a 59% haphazard sample of the state's colleges and universities. The shortcomings of institutional participation is aggravated by the fact that the public institutions participating submitted completed questionnaires on 313 respondents, 33% of their 1978 graduates. The 97 completed questionnaires from private institutions amounted to 36% of their classes of 1978.

Table I shows the numbers of degrees awarded by institutions for 1976-77 and 1977-78 academic years. Inspection of table shows that the public institutions' psychology programs produce nearly ¾ of the bachelors' degree graduates, nine out of ten of the masters' degrees, and all of the doctorates. Both Hollins College and the University of Richmond have substantial numbers of bachelor's degree graduates and the only

master's degree programs offered by the private institutions. Among the public institutions the programs at Longwood, Norfolk State and Virginia State produce no more graduates than some of the private institutions. It may be of interest to note the recent decline in the number of bachelors' degrees awarded by both public and private institutions—down 12% from 1977 to 1978.

Table II shows the demographic characteristics of the questionnaire respondents. Females outnumbered males by approximately 2 to 1. Whites outnumbered blacks and other minorities by an overwhelming majority. Virginia residents constituted 83% of the public institutions' respondents but slightly less than half of the private institutions' respondents.

The substantive items in the questionnaire fell into four categories: (1) The graduates' stated purpose in pursuing their study of psychology; (2) their opinions as to how well their colleges or universities had helped them to achieve their purposes; (3) the graduates' employment; (4) the graduates' further education.

The respondents' purposes in completing their psychology programs can be summarized as follows: both the public and the private institutions' respondents ranked general intellectual and social development in first place; they ranked knowledge in psychology in second place. Preparation for employment and for admission to graduate school were ranked third and fourth, respectively. These rankings are of course biased by the fact that the overwhelming majority of the respondents were recent bachelor's degree graduates.

Table III shows what the respondents felt about how their educational programs has helped them attain their purposes. Examination of the table shows that these graduates were most favorable in their evaluations of the help provided in attaining their liberal arts purposes and least favorable in their evaluations of their programs' help in preparing them for employment. It appears that somewhat more favorable evaluations were given by respondents from the private institutions.

The current employment picture of the respondents is shown in Table IV. It will be noted that employment rates are nearly identical among the public and private institutions' graduates. Fewer than 10% were unemployed and seeking employment. Those neither employed nor seeking included those continuing their

Table I

Council of Higher Education Report

Psychology Majors' Degrees Awarded, 1976-77/77-78

PUBLIC INSTITUTIONS		Bachelor's	Master's	Doctor's
Christopher Newport*		35/41		
George Mason*		87/69	35/40	
James Madison*		79/80	15/17	
Longwood*		9/11		
Mary Washington		40/40		
Norfolk State		13/21	0/3	
Old Dominion		99/84	10/7	
Radford*		32/16	27/37	
University of Virginia*		175/150	7/11	7/9
Virginia Commonwealth*		85/88	30/23	12/20
V.P.I. and S.U.		93/71	12/14	4/3
Virginia State		30/18	3/1	
William and Mary		67/58	4/5	0/3
	SUBTOTALS	844/747	143/158	23/35

PRIVATE INSTITUTIONS

		Bachelor's	Master's	Doctor's
Averett*		6/8		
Bluefield*		13/8		
Bridgewater		9/6		
Eastern Mennonite*		15/10		
Emory and Henry*		10/10		
Hampden-Sydney		23/9		
Hampton Institute		27/16		
Hollins*		30/23	10/1	
Liberty Baptist		12/13 (no alumni records)		
Lynchburg*		12/6		
Mary Baldwin*		16/21		
Randolph-Macon*		22/29		
Randolph-Macon Woman's*		14/6		
Roanoke*		13/26		
Sweet Briar*		8/14		
University of Richmond		40/34	9/10	
Virginia Union		9/8		
Virginia Wesleyan		8/4		
Washington and Lee*		14/6		
	SUBTOTALS	301/257	19/11	

| TOTALS 1976-77/77-78 | 1145/1004 | 162/169 | 23/35 |

* Institutions which participated in the survey.

Table II

Demographic Characteristics of Respondents

	PUBLIC INSTITUTIONS	PRIVATE INSTITUTIONS
Number Completed	313	97
Males	35%	31%
Females	65%	69%
White	94%	95%
Black	5%	4%
Others	1%	1%
Bachelors	81%	99%
Masters	18%	1%
Doctorates	1%	0%
Va. Residents	83%	49%
Birthdate Range	1914-1957	1940-1957
Modal Age	22	22

Table III

Percent of respondents' ratings of degree of help provided by their educational programs in attaining purposes.

Purpose		Very Well	Adequately	Moderately	Not at all
1. Enhance gen'l intell/soc development.	Public	52%	40%	9%	0%
	Private	70%	26%	4%	0%
2. Gain knowledge in interest area.	Public	50%	42%	9%	0.3%
	Private	57%	35%	6%	1%
3. Prepare for employment.	Public	16%	31%	36%	17%
	Private	10%	45%	35%	10%
4. Prepare for prof. schl.	Public	23%	44%	27%	5%
	Private	35%	42%	18%	5%

Table IV

Current Employment of Respondents

	Public %	Private %
Full-Time 30+ hrs./wk.	63	63
Part-Time 15 hrs./wk. min.	10	9
Unemployed and seeking	9	8
Homemaker - no other employment	2	2
Not employed or seeking (may include current students)	16	17
Employed in Virginia	78	58

Employed in:	Public %	Private %
Private enterprise	38	38
Educ. instn/system	21	30
Fed.-State-Loc. Govt.	32	19
Other	9	14

Relat. of employment to Psyc. study:

	Public %	Private %
Directly	37	29
Somewhat	33	46
Not at all	30	25

Learned of present job through:

	Public %	Private %
Already employed before grad	20	9
College placement office	4	10
Employment agency	8	6
Newspaper ad	16	14
Faculty contact/referral	6	9
Friend/relative	28	36
Other	19	17

Overall Salary Range ($1,000's)	Less than 6 to 30	Less than 6 to 17
Median Range	8 to 10	8 to 10
Job satisfaction in terms of:	Highly/Moderately	Highly/Moderately

	Public %	Private %
Challenge	80	81
Salary	71	71
Long-range plans	64	70

Is job step toward career goals?:

	Public %	Private %
Yes	71	73
No	29	27

Table V

Present educational programs of respondents

	Public %	Private %
Enrolled and seeking another degree	29	30
Enrolled, but not seeking degree	8	2
Degree being sought:		
Associate/Bachelors	9	0
Masters	57	76
Doctorate	30	24
Other degree, certificate	4	0

education. The graduates of the public institutions were more likely to be employed in Virginia. Private enterprise, including self-employment, accounts for the largest number of jobs held. A substantial majority viewed their employment as directly or somewhat related to their studies. Nearly 3 out of 4 felt that their jobs were a step toward meeting their long-range career plans.

Median salaries were in the $8,000-$10,000 range and a substantial majority were moderately to highly satisfied with their salaries, the jobs' challenge, and the way in which their employment fitted their long-range plans. It is of interest to note that the old, tried and true method of learning about a job through friends, relatives and teachers is still very important—more so for the private than the public institutions' graduates. College placement offices and employment agencies take a back seat to newspapers' advertisements in their learning about jobs.

Table V shows the present programs of the minority who were pursuing another degree during the same year as their previous graduation. There were 92 of the 313 public institutions' graduates (29%) and 29 of the 97 private insitutions' graduates (30%) who were continuing their educations. Although these percentages are nearly identical the public institutions' graduates were more diverse in the kinds or levels of degrees sought. This is, presumably, a function of both their large number and originally greater diversity in their previous programs.

If the present study were repeated by the Psychology Section of the Virginia Academy of Science or by another section, the experience gained here would suggest that in order to achieve full participation of all departments the following steps might help:

1. After the Section has agreed to conduct the survey it should then establish the survey calendar and procedures at its annual business meeting and appoint a central office for the survey.
2. Once individual college or university department or division chairmen have agreed to par-

ticipate, the survey's central office should secure the alumni mailing lists and the covering letters from each institution.
3. At the scheduled dates the central survey office does all of the original and follow-up mailings and, where necessary, telephones non-respondents.

If the steps suggested were followed, it would, presumably, be necessary to either have financial support from the Academy or a cost-sharing arrangement among the participating institutions. While the Academy has no precedent for institutional research it is certainly capable of making proposals for grants to private or public foundations, and its official sanction and support might be expected to strengthen the chances of a proposal receiving approval and funding.

The questionnaire used in the present study was, as stated at the outset, developed by the Southern Regional Education Board (SREB) as part of its continuing project on comparison of outcome data. SREB can and will serve as a clearinghouse for follow-up surveys in the region and will prepare and distribute comparisons of outcome data.

It would seem obvious that outcome data from follow-up surveys are useful not only to individual educational institutions for their program planning and evaluation, but also that their value can be increased by relating findings to those of similar institutions, at the level of the separate sections of the Virginia Academy of Science, the Academy as a whole, and, with the help offered by SREB, throughout the Southern Region.

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Geometrical Optics of Planar Interfaces[1]

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Abstract—Assuming two media of different indices of refraction are
joined at a planar interface, a derivation of the relationship between
object position and image position is given. The derivation is initially
given using no calculus, and then a shorter procedure, using deriva-
tives, is shown. The dispersive properties of such an interface are also
derived.

Introduction

In the teaching of geometrical optics, traditionally
one seems to go from the introduction of Snells's Law
directly into the treatment of image formation by
spherical interfaces, spherical lenses, for example. The
exact geometry of such situations is often so compli-
cated as to necessitate the introduction of mathemati-
cal approximations, such as the thin lens approxima-
tion. Corrections to this, as well as questions concerning
off-axis image formation are normally delayed until a
discussion of aberrations, and this is often treated only
qualitatively.

A quite normal first application of Snell's Law
would seem to be a study of image formation by a flat
surface bounding two transparent media. The physical
consequences of such imaging should be quite familiar
to any student having experienced spoons in glasses of
water, swimming pools, or bathtubs.

Herein is a mathematical description of the image-
forming properties, as well as the dispersive effects, of
a planar interface between two media of different indi-
ces of refraction. The derivation of the image position
is initially presented using geometry and the notion of
the limit, and the same calculation is then outlined
using differential calculus. Subsequent calculations
are shown using derivatives to shorten the work.

Section II of this paper shows the calculation of the
image position for an object in one medium viewed
from a second medium. Section III shows the connec-
tion of this problem to a time minimizing puzzle. Sec-
tion IV is a calculation of the dispersive effects of a
planar interface, and an example is given of spectrum
formation by a flat water surface.

Calculation of Image Position

The formation of a virgual image by a planar inter-
face between two media of different indices of refrac-
tion is most easily visualized by using a technique of
tracing two rays, distinct, but near one another. Figure
1 shows the geometry associated with the two rays
from an object P a perpendicular distance D below the
media interface I. The medium above the interface has
index of refraction n_1, that below has index of refrac-
tion n_2. The line I represents the intersection of two
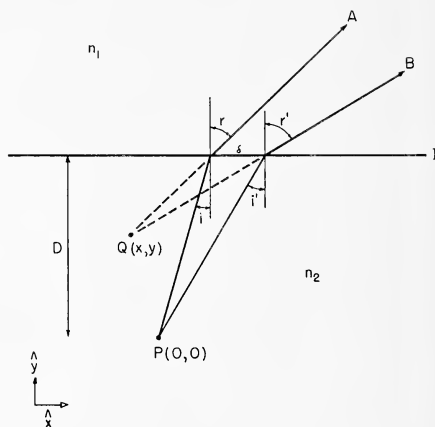
FIG. 1—Ray diagram showing relationship of object, P(O,O), and
image formed by planar interface, Q(x,y).

perpendicular planes—that of the interface and the
plane of the two illustrated rays. Ray A (B) leaves the
origin P(O,O), intercepts the interface normal at an
angle i (i'), and enters the second medium at an angle r
(r') to the normal. From the point of view of an
observer in medium 1, these two rays appear to have
originated from a point Q(x,y), above and to the right
(if $n = n_2/n_1 > 1$) of P(O,O). In the limit as the two rays
approach one another, Q(x,y) becomes the exact
image position. It is the value of x and y as a function of
r (or i) that is sought in this section.[3]

Snell's Law is obeyed by each ray, therefore

$$\sin r = n \sin i \qquad (1)$$

and

$$\sin r' = n \sin i'. \qquad (2)$$

Simple geometry leads to the additional equation

$$D \tan i + \delta = D \tan i', \qquad (3)$$

where δ is the linear distance between the intersection
of A with I, and the intersection of B with I. To find the
intersection of the lines represented by rays A and B as
they travel in the medium of index n_1, the equation for
these lines will be found. The line corresponding to A
can be written

$$y = m x + b,$$

where m is the slope, and b the y intercept. From

geometry, $m = \cot r$. The value of b can be evaluated using the fact that at $y = D$, $x = D \tan i$. The equation for this line can thus be written

$$y = (x - D \tan i) \cot r + D. \qquad (4)$$

Similarly, the line corresponding to ray B in medium 1 has the equation

$$y' = (x' - D \tan i') \cot r' + D,$$

or

$$y' = (x' - D \tan i - \delta) \cot r' + D, \qquad (5)$$

using equation (3) to eliminate i'. These two lines (equation (4), (5)) intersect at $x = x'$, $y = y'$: combining these conditions with (4) and (5) gives

$$(x/D - \tan i - \delta/D) \cot r' = (x/D - \tan i) \cot r. \qquad (6)$$

The x coordinate of the image position can be found by solving equation (6) for x, in the limit i' approaches i. This is expedited by expressing all angles in terms of the angle i. From equation (1)

$$\cot r = ((1 - n^2 \sin^2 i)/n^2 \sin^2 i)^{1/2};$$

from equation 2 and 3

$$\cot i' = (1 + (1-n^2) \tan i + \delta/D)^2)^{1/2}/n (\tan i + \delta/D).$$

Incorporating these into equation (6) gives

$$(x/D - \tan i - \delta/D)(1+(1-n^2)(\tan i+\delta/D)^2)^{1/2}/(\tan i+\delta/D)$$
$$= (x/D - \tan i)(1 - n^2\sin^2 i)^{1/2}/\sin i.$$

Solving for x, in the limit $\delta \to O$,

$$x = D (n^2 - 1) \tan^3 i,$$

or expressed in terms of the angle in medium 1

$$x = D (n^2 - 1)(\sin^2 r/(n^2 - \sin^2 r))^{3/2}. \qquad (7)$$

Equations (7) and (4) immediately yield the y coordinate of the image,

$$y = D (1 - ((1 - n^2 \sin^2 i)/(1 - \sin^2 i))^{3/2}/n),$$
$$y = D (1 - n^2 ((1 - \sin^2 r)/(n^2 - \sin^2 r))^{3/2}). \qquad (8)$$

This same result is attainable much more simply, if one is willing to sacrifice physical insight in favor of mathematical elegance. Considering only the single ray, A, its equation in medium 7 is given by equation 4,

$$y = (x - D \tan i) \cot r + D.$$

The fact that two nearby rays from $P(O,O)$ will appear to emanate from the same point $Q(x,y)$ implies that for this point

$$dy/di = dx/di = O.$$

Differentiating equation (4) with respect to i, and incorporating these conditions,

$$O = (x/D - \tan i) d(\cot r)/di - \cot r \, d(\tan i)/di.$$

Using equation (1) to evaluate $d(\cot r)/di$ leads to an equation for x identical to (7) and use of equation (4) gives a result for y identical to (8).

Figure 2 shows results of equations (7) and (8), image positions as a function of i for media of relative index of refraction $n = 1.5$. Note that when viewed from directly above, the image is displaced only along the y axis from the object,

$$x = O, \quad y = D (n - 1)/n;$$

when viewed along a line essentially parallel to the interface, the image is on the interface, and displayed laterally

$$y = D, \quad x = D/(n^2 - 1)^{1/2}.$$
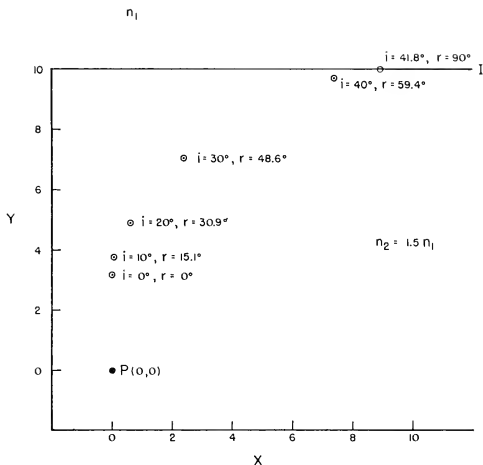
FIG. 2 — Image position x, y as a function of angle of incidence i and angle of refraction, r, for $n = 1.5$.

Drowning Swimmer Problem

The mathematics of the last section is applicable to a problem recently seen in the puzzle section of a scientific journal (*Technology Reivew* 78:64, June, 1976). A somewhat more general statement of the problem reads as follows (see figure 3).
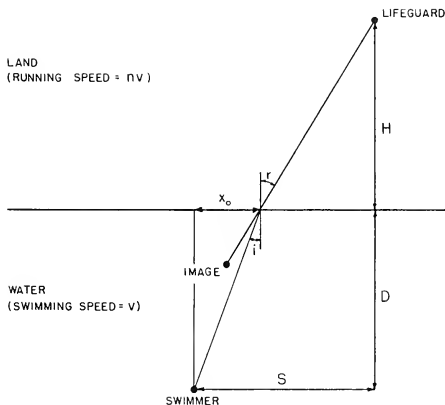
FIG. 3—Geometry of drowning swimmer problem.

A lifeguard on shore, a distance H from the straight shoreline of a body of water, spots a drowning swimmer a distance D from the shoreline, displaced a distance S parallel to the shoreline from him. If he can run a factor of n times faster than he can swim, at what point on the shore should he enter the water in order to minimize his time of travel to the swimmer?

The connection between this problem and the optics of section II is made through Fermat's principle. Fermat explains that light knows intuitively what the lifeguard must stop and think about: light, is going from one point to another, travels the path which will minimize the time of travel. The lifeguard should travel (backward) along the light ray which would reach his eye, having emanated from the swimmer, traveled to the shoreline in a medium of index of refraction n_2 and then to him through a medium of index of refraction n_1 (such that $n_2/n_1 = n$). In other words, the lifeguard should initially run towards the "image" of the drowning swimmer.

Consider a Cartesian coordinate system equivalent to that of figure 2, with the swimmer at the origin, and define the angles i, r as in figure 2. Simple consideration of the two right triangles in figure 3 yields

$$\tan i = x_0/D,$$

and

$$\tan r = (S - x_0)/H.$$

Using equation (7) to eliminate the angular dependence from these equations results in the expression

$$(S - x_0)/H = (n\, x_0/(D^2 - (1 - n^2)\, x_0^2))^{1/2},$$

which is transformable into a quartic equation for x_0 as a function of n, H, D, and S. Numerical techniques are necessary to give x_0 for specific values of these independent variables.

Dispersion

Due to the frequency dependence of the index of refraction of all transparent materials, light of different colors is refracted to different degrees at planar interfaces. "Rainbow" effects are often visible (and almost as often ignored) when white light, travelling in a transparent medium, enters the air through a planar interface.

Whereas the mathematics of this problem can also be handled with techniques similar to those of section II (using limits, but no calculus), the use of differentials greatly simplifies and shortens the effort, and they will be used here.

Assume a point source of white light to exist in a medium of refraction n_2, to be observed from a medium with index of refraction n_1. The two media are assumed separated by the planar interface I. The relative index of refraction $n = n_2/n_1$ is assumed to be a known, differentiable function of the light frequency. Figure 4 shows the geometry of this situation, and defines the parameters to be used in the following derivation. The two rays depicted represent light of slightly differing frequencies, both of which impinge on the observation point. The observer sees them as coming from different directions, and thus will see the
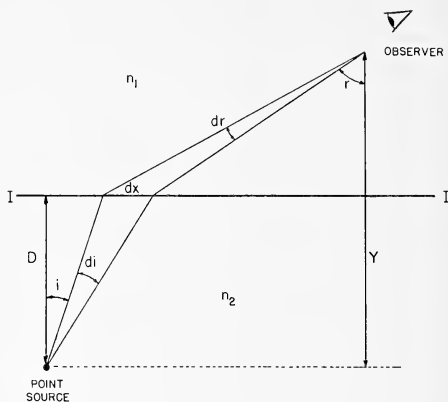
FIG. 4—Ray diagram for dispersion calculation.

image of the point source at different positions for different frequencies.

Refraction at the boundary for each ray is dictated by equation 1,

$$\sin r = n \sin i$$

Differentiation of this equation with respect to the relative index of refraction n yields

$$\cos r\, dr/dn = \sin i + n \cos r\, di/dn$$

Use of the chain rule on the "i" derivative enables one to rewrite this expression as

$$\frac{dr}{dn} = \sin i/(\cos r - n \cos i\, \frac{di}{dr})$$

The term di/dn is most easily calculated by relating i to r via the differential line segment dx:

$$dx = d \sec^2 i \sin (di) = (D - Y) \sec^2 r \sin (dr)$$

It follows that, for infinitesimal di, dr;

$$\frac{di}{dr} = (D - Y) \sec^2 r/(D \sec^2 i)$$

Inserting this into equation (9), and making use of equation (1), gives the following equation, describing the angular dispersion of light at the observer as a function of wavelength;

$$\frac{dr}{dn} = \frac{n \sin r \cos^2 r}{n^2 \cos^3 r + \dfrac{Y-D}{D} (n^2 - \sin^2 r)^{3/2}} \qquad (10$$

To illustrate the use of this formula, an example will be given of a situation in which the dispersive effects of a flat surface are easily observed. A 4' deep section of a swimming pool is observed by a person whose eyes are 6' from the surface of the water (D = 4', Y = 10''). If a point source of white light were placed at the bottom of the pool, the observer would see a spectrum when observing the source at all angles except directly above (r = o). The angular size of this spectrum can be calculated upon picking a value for the angle of observation (60°, e.g.) and realistic values for the refractive
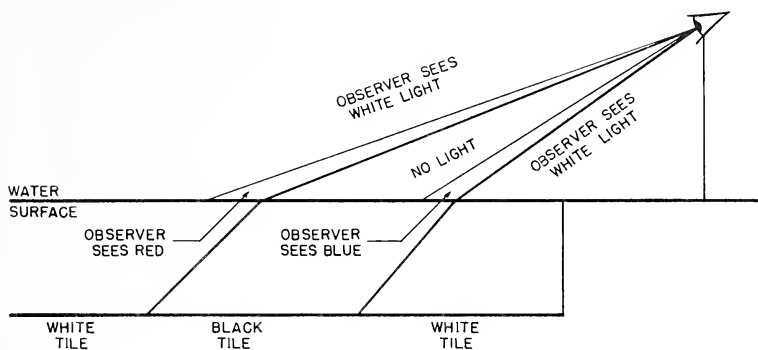
FIG. 5—Ray diagram showing results of observation of black region surrounded by white on pool bottom.

index of water for visible light ($n_{av.}$ = 1.335, dn = .013 for limits of visible spectrum). Using the given data in equation (10) yields dr = 2.1 ×10^{-3} radians = .12°.

Unfortunately, most swimming pools do not have point light sources on the bottom. The effect is destroyed if the underwater light source (or reflective surface, like light colored pool floors) is extended. The spectra from the various points at the pool bottom recombine at the eye, giving the sensation of white light. The effect is easily seen, however, at the boundary between a light area of pool bottom (white tile, e.g.) and a dark area of pool bottom (black tile, e.g.). Since little or no light reaches the eye from the dark area, a section of the spectrum reflected from the nearby light colored area should be visible superimposed over the dark area, near the boundary, from the observer's point of view. The maximum effect is visible if the dark-light boundary is perpendicular to the plane of the observer and line of sight; no effect is visible if the boundary is in that plane. Figure 5 shows the angular regions of light entering the eye in the discussed example. Away from the dark region, the observer sees the white tiles as white. At the black

white boundary nearest the observer, the blue end of the spectrum will be seen just beyond the boundary. At the white-black boundary most distant from the observer, the red end of the spectrum will be seen just beyond the boundary. With the data given in the paragraph above, the two colored regions should have an angular size of about .1°, about the angular size of a 1″ section of pool floor seen by the observer. This is easily observed.

Footnotes

[2]Deceased.

[3]The image position can be found approximately by simply constructing the ray diagram of Figure 1, enforcing Snell's law for i, r and i′ r′, and locating the intersection point Q of the emerging rays. This technique is used to construct imge positions in F. a. Jenkins and H. E. White, *Fundamentals of Optics* (McGraw Hill, New York), p. 37.

Response of Aggressive versus Non-Aggressive Isolates of *Ceratocystis ulmi* to Benzamidazole Carbamate Fungitoxicants

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Abstract—Bioassay procedures for the *in vitro* response of aggressive and non-aggressive strains of *Ceratocystis ulmi* to benzimidazole fungitoxicants were evaluated. The zone of inhibition (ZOI) was larger at 5 ml, sharpest at 20 ml, but best overall at 10 ml agar/plate. Percentage of agar and type of Petri plate made no difference in ZOI. A pre-incubation period of 48 h at 4 C produced the best ZOI. Aggressive isolates were more tolerant to the fungitoxicants than the non-aggressive ones.

Introduction

It is important to know when examining the effects of a fungitoxicant on a fungus whether different cultural or geographical isolates of the fungal pathogen respond in different ways to the fungitoxicant. In 1971, a major epidemic of Dutch elm disease developed in southern Britain (Gibbs *et al.,* 1972). In searching for an explanation for the new epidemic, Brasier and Gibbs (1973) discovered that the form of *Ceratocystis ulmi* (Buism.) C. Moreau associated with the epidemic was more aggressive than isolates obtained elsewhere in Great Britain. When *C. ulmi* isolates from all over the world were examined, two culturally distinguishable groups emerged. Gibbs and Brasier designated these groups as aggressive or non-aggressive strains. Both forms were found readily in North America, while only the non-aggressive strain was generally found in Europe (Gibbs and Brasier, 1973; Schreiber and Townsend, 1976b).

Colony characteristics form the basis for distinguishing the aggressive from the non-aggressive form. In general, the aggressive isolates are fast growing with aerial mycelium, giving the colony a fluffy or cottony appearance. The non-aggressive isolates, on the other hand, are slow growing with a waxy or yeast-like appearance (Brasier and Gibbs, 1975). The term, non-aggressive, however, should not be confused with the term apathogenic. The non-aggressive isolates are pathogenic, but disease development within infected trees is slower than those trees infected with an aggressive isolate (Brasier and Gibbs, 1976).

The objective of the present study was to examine, by the bioassay disk technique (BDT), any differences in effects of benzimidazole fungitoxicants upon aggressive and non-aggressive strains of *C. ulmi* obtained from different areas of the world. To accomplish this objective, it was first necessary to investigate the different parameters governing the disk bioassay technique and to determine a model system for use in fungicide testing.

Materials and Methods

Parameters of the Disk Bioassay Technique (DBT). The DBT consisted of placing a 13-mm bioassay disk containing 100μl of a 100μg/ml solution of methyl-2-benzimidazole carbamate phosphate (MBC • H_3PO_4) on a glucose-yeast extract agar (GYEA) plate, surface-seeded with spores of *C. ulmi*. The plate was first incubated at 4 C for 24 h to allow diffusion of the toxicant, then at 25 C for about 2 wks to allow growth of *C. ulmi*. The Zones of Inhibition (ZOI) were then recorded. In Test I, GYEA plates contained varying depths of agar with 5, 10, 15, or 20 ml/plate with all other variables held constant. In Test II, plates were incubated at 4 C for various time periods: O, 24, 48, 72 and 96 h. In Test III, different concentrations of agar (1.0, 1.5, 2.0%) in the GYEA were used. Test IV consisted of examining the effect of glass versus plastic Petri dishes on DBT. Only 9 cm-diameter plates were used in these and the following experiments. For each test there were 12 replications/treatment, and each test was repeated at least twice. Results were analyzed by Duncan's new multiple range test (Walpole and Myers, 1972).

Bioassay of Aggressive versus Non-Aggressive Strains of C. ulmi One hundred μl of a 10μg/ml solution of either methyl-2-benzimidazole carbamate (MBC), MBC•HCl or MBC•H_3PO_4 were applied to a 13 mm cellulose penicillin bioassay disk. The disk was placed on GYEA surface-seeded with conidia from one of six *C. ulmi* isolates. The plate was stored at 4 C for 24 h and incubated at 25 C for 48 h. A ZOI was recorded. The six *C. ulmi* isolates used included both an aggressive and a non-aggressive isolate from the Netherlands, the United Kingdom and the United States (Iowa). The experiment was repeated twice with 10 replications/isolate/chemical and analyzed with Duncan's New multiple range test at the 5% level (Walpole and Myers, 1972).

Results and Discussion

Parameters of the DBT. Increase in size of the ZOI was inversely proportional to an increase in the quantity of agar per plate. While the ZOI was significantly larger at an agar volume of 5 ml, the ZOI was sharpest at 20 ml of agar/plate. Ten ml of agar/plate yielded the best overall ZOI; it was large, yet sharp and easy to read (Table I).

Table I. Effect of depth of agar on the size of the zone of
          inhibition (ZOI) in the disk bioassay technique.

Depth of Agar (ml)	Mean of ZOI (cm)	Trenchancy of ZOI
5	6.45 a*	hazy
10	6.17 b	sharp
15	5.73 c	sharp
20	5.46 d	very sharp

* Within column means followed by the same letter are not significantly
  different at the 5% level of probability as determined by Duncan's
  new multiple range test.

Table II. Effect of incubation period at 4 C on the size of
           the zone of inhibition (ZOI) in the disk bioassay technique.

Incubation Period (h)	Mean of ZOI (cm)	Trenchancy of ZOI
0	4.56 a*	hazy
24	5.32 b	sharp
48	6.19 c	sharp
72	6.67 d	hazy
96	7.10 e	hazy

* Within column means followed by the same letter are not significantly
  different at the 5% level of probability as determined by Duncan's
  new multiple range test.
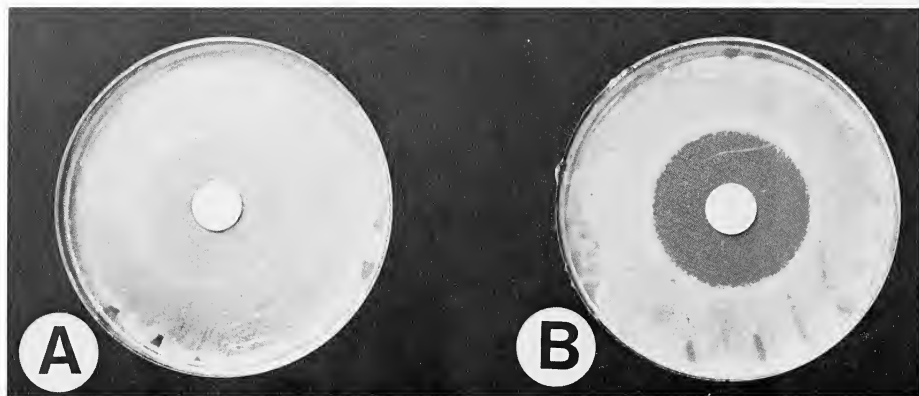
FIG. 1—Zones of inhibition of aggressive (A) versus nonaggressive (B) isolates of *Ceratocystis ulmi* after incubation at 25 C for 4 wks.

Increase in the size of the ZOI was directly proportional to an increase in the incubation period at 4 C. An incubation period of 48 h at 4 C produced the largest ZOI that was sharp and easy to read (Table II).

Percentage of agar and type of Petri dish had no significant effect on the ZOI.

After examining the parameters of the BDT, the necessity of holding all variables constant when conducting comparative studies was clear, especially the quantity of agar/plate and the incubation period at 4 C. An incubation period at 4 C of 48 h, 10 ml of agar/plate and a medium containing 2.0% agar dispensed into plastic Petri dishes were chosen for the model system.

Bioassay of Aggressive and Non-Aggressive Isolates of C. ulmi. For all fungitoxicants, the ZOI of the Dutch non-aggressive isolate was significantly larger than that of the Dutch aggressive isolate. The zones of inhibition of the English isolates were not significantly different, and those of the Iowa isolates were not consistent among replications. The ZOI of the non-aggressive isolates was very sharply demarked, and there was no fungal development in the ZOI after an incubation period of 4 wks. The aggressive isolates, however, exhibited a hazy ZOI which was completely overgrown by the fungus after incubation of 2 wks at 25 C (Figure 1).

Because of the hazy appearance and eventual overgrowth of the ZOI by the fungus with aggressive isolates, it was concluded that the aggressive isolates exhibit a more tolerant or less sensitive reaction to the fungitoxicants than the non-aggressive isolates. This phenomenon coupled with natural occurrence of MBC-tolerant *C. ulmi* isolates reported by Schreiber and Townsend (1976a), might explain in part the variation in efficacy of treatment of Dutch elm disease with benzimidazole compounds.

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Obituaries

WILLIAM MILLER HINTON

William M. Hinton, Professor Emeritus of Psychology, died in Lexington, Virginia, on January 1, 1979.

Born in Kentucky, Dr. Hinton's affiliation with Washington and Lee University began when he enrolled as a freshman in the fall of 1925 and continued until the first day of this new year. He received a bachelor's and then a master's degree from Washington and Lee and subsequently earned his doctorate in psychology from Ohio State University. Except for a year of residence in graduate school and for four years of military service during World War II, in which he attained the rank of lieutenant colonel, Dr. Hinton remained at Washington and Lee during his entire academic career—a period of more than half a century. The University of Virginia was fortunate to have him teach as Visiting Professor of Psychology for 25 successive summers beginning in 1947. His contributions to professional organizations were recognized by his colleagues at other institutions through his election to positions of leadership in several learned societies, including the presidency of the Virginia Psychological Association in 1956, the Virginia Academy of Science in 1959, and the Southern Society for Philosophy and Psychology in 1962.

ESMARCH SENN GILREATH

Esmarch Senn Gilreath, head of the chemistry department at Washington and Lee University for 15 years until 1970 and a member of the W&L faculty for 29 years, died at his home March 3, 1979 at age 74.

Prof. Gilreath was born September 21, 1904, in North Wilkesboro, N.C., the son of the late Dr. and Mrs. Frank Hatchett Gilreath. He earned his A.B., M.A. and Ph.D. degrees in chemistry from the University of North Carolina, where he also taught while working on his doctorate. He spent a year as a research chemist for American Enka Corp. Before joining the W&L chemistry faculty in 1946. He became department head in 1955 and returned to full-time teaching in 1970. He retired in 1975.

"He was an effective teacher—particularly in designing and developing experiments for student use," William J. Watt, dean of the College at W&L and a fellow chemistry professor, had remarked upon Dr. Gilreath's retirement in 1975.

The son of a physician, he was particularly interested in Washington and Lee's pre-medical curriculum, and during most of his teaching career he was the university's advisor to pre-med students.

He was the author of a number of college-level chemistry textbooks, including "Elementary Qualitative Analysis" (1969), "Experimental Procedures in Elementary Qualitative Analysis" (1968), "Fundamental Concepts of Inorganic Chemistry" (1958) and "Qualitative Analysis" (1954, translated into Spanish and published in that language in 1960).

His scholarship and writing were so highly regarded that one publisher wrote to him in 1968: "We could seek further critical opinions at this point, but prefer to go right ahead with copy editing without further delay. We are confident of the quality of the manuscript".

During the summers, Dr. Gilreath was frequently a visiting professor at other colleges, including the Universities of North Carolina, British Columbia, and Oregon. He spent much of his free time gardening and was a science-fiction enthusiast.

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THE VIRGINIA JOURNAL OF SCIENCE

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The original and two copies of each manuscript and of all figures therein are required. *Authors should submit names of three potential reviewers.* All articles should be typewritten, double-spaced throughout, on one side of good bond paper (8½ × 11 inches). Margins should be not less than 1¼ inches on any border. Each manuscript should be complete and final when submitted. It should include the title, author's name and affiliation, and proposed running title, all appear-ing on a title page, and a required abstract summarizing the text, particularly the results and conclusions, also appearing on a separate page.

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VIRGINIA JOURNAL OF SCIENCE
OFFICIAL PUBLICATION OF THE VIRGINIA ACADEMY OF SCIENCE

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EDITORIAL

The publication of Volume 31, issues 1 and 2, Spring and Summer, in a single cover brings the Virginia Journal of Science back to a regular schedule. When we follow up this issue late in the year with the Proceedings 1980 issue, the Journal will have resumed regular quarterly publication. The editor wishes to express his great appreciation to the authors, reviewers, and Academy officials, all of whom have been appropriately patient, prompt, and supportive. Many of the headaches that would normally be an editor's have been borne by Business Manager Frank Kizer or former Academy President Dale Ulrich. Mr. Rick Kinkead, who handles the printing of the Journal at Good Printers, Inc. has provided this very green editor with extraordinary help and guidance. Thanks is also due the members and subscribers for their understanding for the delays during the transition of the Journal to a new editor and a new printer.

History of the Section of Statistics

Boyd Harshbarger

Professor Emeritus and Former Head
Department of Statistics
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

[Some of us tell our students that statistics is a field which was born during the second World War. The Statistics Section was born about the same time. With the watchful care of Dr. Harshbarger, it grew and became an important component of the Academy. His contribution, both to the Statistics Section and to the Academy, has been one of continued investment of time and leadership. Given his long involvement in the Statistics Section, Dr. Harshbarger was asked to provide this history of the section—Van Bowen, Statistics Editor.]

The Section of Statistics of the Virginia Academy of Science was proposed by Dr. Boyd Harshbarger, Professor of Statistics of the Virginia Polytechnic Institute, to Dr. E. C. L. Miller, Secretary-Treasurer of the Virginia Academy of Science, Medical College of Virginia, in December 1943. In the letter to Dr. Miller, he requested permission for a section of statistics in the Virginia Academy of Science at the Richmond Meetings, May 9-10, 1944. The permission for this meeting was granted, and Dr. Harshbarger immediately contacted Dr. G. P. Gray, Dean of the Medical College of Virginia, and asked him to serve as Chairman. Mr. J. A. Ewing of the State Department of Agriculture, Richmond, was asked to serve as Vice-Chairman and Dr. Boyd Harshbarger as Secretary. The latter immediately set about organizing a program for the May meeting. The first meeting consisted of 19 papers on applied statistics. The special attraction of the meeting was the invited talk by Miss Gertrude Cox, Director of the Institute of Statistics in North Carolina. Mr. Walter Hendrix of the Department of Economics and Dr. A. A. Pope of the U.S.D.A. Applied Industry also presented papers. This meeting of the section attracted a large audience of fifty people. Fifteen members of the Academy actually listed Statistics as their first choice during registration. Officers were elected for 1945 as follows: Chairman, Mr. J. A. Ewing, Crop Reporting Service, Richmond; Vice-Chairman, Dr. H. H. Zimmerley, Director of the Virginia Truck Experiment Station, Norfolk, (Dr. Zimmerly, who was a very influential member of the Academy and who was very much interested in Statistics, died before he could serve as Vice-Chairman.)

There was no formal meeting of the Virginia Academy of Science held during 1944-45, but in 1945-46 the Academy again met with Mr. J. A. Ewing as Chairman and Dr. Boyd Harshbarger as Secretary of the Section of Statistics. Two of the papers read at the

Section of Statistics were recommended by the Research Committee for the J. Shelton Horsley Award. One of these papers was by Dr. Boyd Harshbarger on, "Rectangular Lattices," and the other was by Dr. D. B. DeLeury on, "Estimation of Biological Populations." The awarding of this prize for highly meritorious original research to two separate papers set a precedent and helped to formalize the Statistics Section as a regular section of the Virginia Academy of Science. On May 11, 1946, the Statistics Section was formally recognized as a section of the Academy.

The Section of Statistics has had a full program since its inception. The program usually begins around 9:00 a.m. on Thursday and runs through to Friday noon or later. It has been the custom each year to bring in outstanding speakers to this section. Some of these distinguished speakers have been Dr. Harold Hotelling, University of North Carolina; Dr. W. A. Hendricks, U.S.D.A.; Dr. Clifford Maloney, Chemical Corps, U.S. Army; Dr. David Blackwell, University of California; Dr. Jack Youden, Bureau of Standards; Dr. Herbert Thom, U.S. Weather Bureau; Dr. H. O. Hartley, Texas A&M; Dr. Churchill Eisenhart, National Bureau of Standards.

It is interesting to note that Dr. D. B. DeLeury, one of the earlier members of this section, is now Dean of the Mathematics and Applied Mathematics Division of the University of Toronto. This is the largest Mathematics and Applied Mathematics Department in the world. Dr. DeLeury was not only a member of this section but was a winner of the J. Shelton Horsley Research Award.

The caliber of papers of this section is best shown by the number of times members of this section have won the J. Shelton Horsley Research Award. In 1951 it was won by Dr. D. B. Duncan with his paper, "A Significance Test for Differences between ranked Treatments on an Analysis of Variance and on the Properties of the Multiple Comparisons Test"; in 1956 by Mr. M. C. K. Tweedie with his paper, "Statistical Properties of Inverse Gaussian Distributions"; in 1956-57 by Dr. D. E. W. Schumann and Dr. R. A. Bradley with, "Comparison of the Sensitivities of Similar Experiments: Part I. Theory, Part II. Applications"; and in 1972 by Dr. I. J. Good and Dr. R. A. Gaskins with, "Global Nonparametric Estimation of Probability Densities."

Dr. Boyd Harshbarger was elected President-Elect of the Virginia Academy of Science in 1948 and Presi-

dent in 1949. In this capacity he served on the Council from 1949 through 1953. He founded the Virginia Journal of Science new series and served as its Editor-in-Chief from 1950-55. Before beginning the Journal he personally solicited donations amounting to $1,500.00 and when he relinquished the successful Journal in 1955, he left a balance in excess of $5,500.00.

Dr. Ralph A. Bradley was elected to the Council of the Virginia Academy of Science in 1958.

The members of the Section have served on numerous committees and have served as Chairmen of a number of very important committees of the Academy.

The chairman of the Section include many outstanding men in the field of statistics. How many of them do you know as authors, innovators or outstanding scholars?

1943-44	*1955-56*	*1967-68*
G. P. Gray	M. C. K. *Tweedie*	Valiant Mah
1944-45	*1956-57*	*1968-69*
No meeting	John E. Freund	I. J. Good
1945-46	*1957-58*	*1969-70*
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1946-47	*1958-59*	*1970-71*
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Rutledge Vining	Ira A. DeArmon, Jr.	R. H. Myers
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Seasonal Distribution of Rotifers in Lake Maury, Newport News, Virginia

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Abstract—Rotifers are among the most abundant fauna found in fresh water lakes, ponds and pools, exceeded only by protozoans. In Lake Maury, Va., the relationships between rotifer genera present and time of year is marked. Which rotifers were present were clearly related to changing parameters of temperature and pH in a one year study. A species list of rotifers known to occur in Lake Maury is included. Examinations of this lake are continuing and further data will be made at a later date.

Introduction

Rotifers are among the most abundant fauna found in fresh water lakes, ponds and pools, exceeded only by protozoans. Essentially cosmopolitan, rotifers offer a unique experience to the microscopist, for their exotic shapes can intrigue even the most experienced limnologists. The environmental variables affecting distributions of rotifers have been reviewed by many authors, including Miracle (1977), Carlin (1943), Chengalath and Fernando (1973), Fairchild, Stemberger, Epskamp and Debaugh (1977), Hutchinson (1967), Stemberger (1974). This paper is an attempt to examine the limnetic and littoral rotifers in a small fresh water in southern Virginia, Lake Maury, and the relationship between the presence of various rotifers and two measured environmental parameters, water temperature and pH. Dissolved oxygen, photoperiods, population dynamics, predation and chemical availability were not measured. The only other work on rotifers of Virginia is the one by Harring (1913), which lists the rotifers of Washington and vicinity.

Study Area

Lake Maury is an artificial lake in southeast Virginia, located near the mouth of the James River (Fig. 1). The lake is located within Newport News city limits, and is surrounded by the wooded grounds of the Mariner's Museum. Lake Maury is fed by runoff streams from the surrounding rural areas. The Mariner's Museum staff can regulate the level of the lake by controlling the outflow to the James, and can therfore maintain, to some extent, the Lake's stability.

Materials and Methods

Samples were taken several times a month at one or more of the 17 sites from February 1978 to January 1979. Quart jars, pre-rinsed with lake water, were used for collecting at each of the sample sites. All samples were taken from shore areas. When present, available water plants were included in the sample jars. During
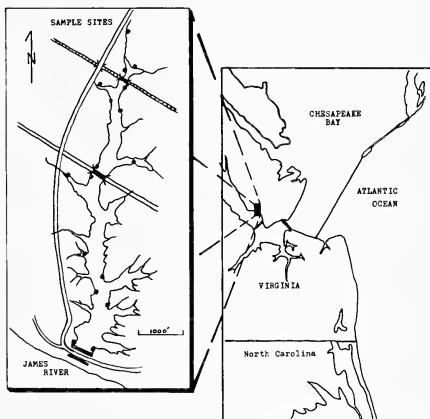
FIG. 1—Mouth of Chesapeake Bay with Inset Showing Location of Lake Maury and Sample Sites.

regular sampling, submerged water plants were used to fill ½ the sample jar, and the rest was filled with available sample water. Sampling was also done with a 150mu plankton net. Approximately once a month at one of the sample sites (on a rotating basis) the plankton net was passed through the water and emptied into sample jars as many times as it took to fill the jars. Each time a sample was taken by either method, site number, date, time, air and water temperatures, and pH were recorded for each site. Hydrion wide range papers, pH 1-12, provided a rough indication of the pH. In the lab, sample jars were opened and placed to one side of an intense light. After an hour or so, the meniscus on the bright side of the jar contained most of the free swimming life in the jar, including the rotifers. The area was pipeted into a watchglass for low power examination. Small fragments of water plants were also included in the watchglass to insure that the examination process was as complete as possible. Further investigations were carried out at powers high enough for precise identifications. Neo-Synephrine was used for narcotising the rotifers, and when fixed, Flemmings fluid or 10% formalin was used. Due to the sampling technique, rotifers of the order Bdelloidea were not fully represented. Bdelloids prefer the benthos and mosses to the open waters examined.
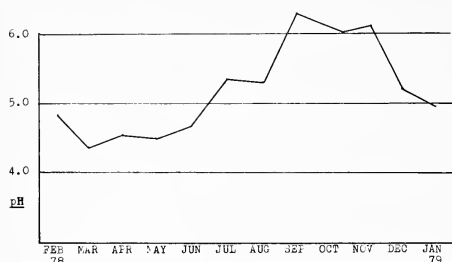
FIG. 2—Mean pH of Water Samples Collected Monthly.
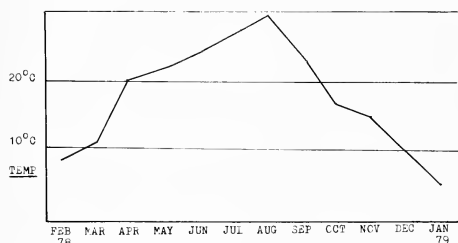
FIG. 3—Mean Temperature of Water Samples Collected Monthly.

Results

Both pH and temperature varied with the seasons, reaching highs in the late summer at pH 6.38 and 29.4° C. (Figure 2 & 3). Lowest pH's and temperatures were recorded in March and January.

Seasonal distributions for selected genera are illustrated in Table I. Genera such as *Lepadella, Trichocerca,* and *Notommata* were present most of the year, whereas *Brachionus, Platyias,* and *Scaridium* were present only during summer months. *Lophocharis, Synchaeta* and *Trichotria* were found only in the winter and early spring months. Appendix I is a list of rotifers known to occur in Lake Maury. A total of 130 different species were found.

Discussion

The presence or absence of selected rotifer genera may be subject to many factors. The factors measured here were temperature and pH. *Brachionus, Platyias* and *Scaridium* appeared in the month of June, when the pH was 4.6, and persisted until October, November and December when the lake water became less acidic (Figure 2, Table I). The temperature of the lake water during that time went from 22° C. to 17° C. (Figure 3). During October and November when these rotifers were disappearing, other genera such as *Lophocharis, Kellicottia* and *Synchaeta* appeared. These species were present in the water from the point that the lake

temperature dropped below 20.6° C. until the temperature rose above 20.6° C. (Figure 3, Table I). There were persistent species that remained active in the lake throughout most of the year: *Euchlanis, Lepadella, Trichocerca, Notommata, Lecane* and *Polyarthra.* Miracle (1977) suggests that these changes in rotifer populations may be due to an 'annual planktonic succession' rather than to arbitary external stimuli.

Lake Maury is an example of a mildly acidic freshwater lake on the Virginia coastline. The list of rotifers should not be considered typical of all Virginian lakes due to the extreme climate variations found throughout the state. My examinations of Lake Maury are continuing and additional data on the effects of seasonal variables on rotifer populations will be published at a later date.

Acknowledgements

I would like to thank Dr. Ronald Mollick for his invaluable help in preparation of this manuscript for publication.
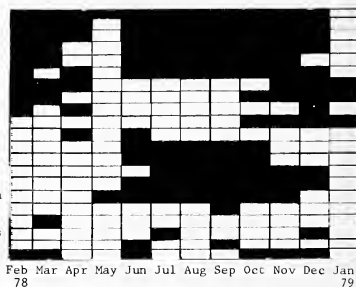
TABLE I—Monthly appearance of 21 selected rotifer genera found in Lake Maury. Presence of one or more representatives of the genus, not number of species or population site, is indicated by the blackened square for that month. Not many samples were taken in May.

List of Rotifer Species Found in Lake Maury, Va.[1]

Phylum Nemanthelminthes, Class Rotatoria,
  Subclass Eurotatoria
    Superorder Digononta
      Order Bdelloidea
          Dissotrocha aculeata (Ehrenberg)
          D. medioculeata (Janson)
          Embata socialis Long
          Macrotrachela decora (Bryce)
          Philodina roseola Ehrenberg
          P. megalotrocha Ehrenberg
          P. brevipes (Murray)
          Rotaria macrura Ehrenberg
          R. neptunoidea Milne

[1]Taxonomic classification follows Koste (1978).

Superorder Monogononta
  Order Ploimida
    Family Asplanchnidae
      Asplanchna seiboldi Leydig
      A. brightwellii Gosse
    Family Brachionidae
      Brachionus quadridentatus Herman
      B. budapestinensis Daday
      B. angularis Gosse
      Keratella cochlearis cochlearis Gosse
      K. cochlearis anguliferna (Lauterborn)
      K. cochlearis micracantha (Lauterborn)
      K. cochlearis tecta (Lauterborn)
      K. hispida pustulata (Müller)
      K. crassa Ahlstrom
      Kellicottia bostoniensis (Rousselet)
      Platyias quadricornis (Ehrenberg)
    Family Colurellidae
      Colurella uncinata deflexa (Ehrenberg)
      C. oxycauda oxycauda (Carlin)
      C. colurus compressa (Lucks)
      C. obtusa obtusa (Gosse)
      Lepadella acuminata (Ehrenberg)
      L. imbricata Harring
      L. similis (Lucks)
      L. cryphaea Harring
      L. triptera Ehrenberg
      L. patella (Müller)
      Lophocharis hutchinsoni Edmondson
      L. oxysternon (Gosse)
      L. salpina Ehrenberg
      Squatinella mutica (Ehrenberg)
    Family Dicranophoridae
      Dicranophorus epicharis Harring-Myers
      D. caudatus Harring-Myers
      Encentrum spatiatum (Wulfert)
      E. saundersiae Harring-Myers
    Family Euchlanidae
      Beauchampiella eudactylotum
        (de Beauchamp)
      Euchlanis callista Myers
      E. calpidia Myers
      E. deflexa (Gosse)
      E. dilatata Ehrenberg
      E. meneta Myers
      E. triquetra Ehrenberg
    Family Gastropodidae
      Gastropus hytopus (Ehrenberg)
    Family Lecanidae
      Lecane luna (Müller)
      L. luna presumpta Ahlstrom
      L. sverigis Ahlstrom
      L. ludwigii (Eckstein)
      L. stokesii (Pell)
      L. leontina (Turner)
      L. ungulata (Gosse)
      L. sibina Harring
      L. (Monostyla)quadridentata Ehrenberg
      L. (M.) closterocerca Schmarda
      L. (M.) hamata Stokes
      L. (M.) cornuta (Müller)

L. (M.) lunarias (Ehrenberg)
L. (M.) decipiens Murray
L. (M.) arcuata Bryce
L. (M.) scutata Harring-Myers
L. (M.) styrax Harring-Myers
Family Mytilinidae
  Mytilina ventralis macrocantha
    (Ehrenberg)
Family Notommatidae, Subfamily
  Notommatinae
  Cephalodella gibba (Ehrenberg)
  C. racuna Myers
  C. plicata Myers
  C. mucosa (Myers)
  C. doryphora Myers
  C. catellina (Müller)
  C. ventripes (Dixon-Nutall)
  C. forficata (Ehrenberg)
  Itura myersi Wulfert
  I. viridis (Stenroos)
  Monommata phoxa Myers
  M. caudata Myers
  M. diaphora Myers
  M. appendiculata Stenroos
  M. viridis Myers
  Notommata pseudocerverus
    de Beauchamp
  N. pachyura (Gosse)
  N. copeus Ehrenberg
  N. cyrtopus Gosse
  N. triptus Ehrenberg
  Pleurotrocha petromyzon Ehrenberg
  P. vernalis Wulfert
  Taphrocampa selenura (Gosse)
  T. anulosa (Gosse)
Family Proalidae
  Proales sordida fallaciosa Gosse
  P. gigantea Glasscot
  P. palummeka Myers
  P. cognita Myers
  Proalinopsis selene Myers
Family Synchaetidae
  Polyarthra dolichoptera (Idelson)
  P. proloba Wulfert
  P. major (Burckhardt)
  P. minor (Voight)
  P. euryptera (Wierzejske)
  P. remata (Skorikov)
  Synchaeta littoralis Rousselet
  S. pectinata Ehrenberg
  S. tremula (Müller)
  S. curvata Lie-Petersen
Family Trichocercidae
  Trichocerca cavia (Gosse)
  T. vernalis (Haurc)
  T. tenuior (Gosse)
  T. similis Wierzejski
  T. tigris (Müller)
  T. weberi (Jennings)
  T. stylatus (Gosse)
  T. bicuspes (Pell)

T. carinatus (Lamarck)
T. elongata (Gosse)
Family Trichotridae
Trichotria pocillum (Müller)
T. tetractis (Ehrenberg)
Order Gnesiotrocha, Suborder Flioscularicea
Family Testudinellidae
Testudinella patina (Hermann)
T. intermedia (Gosse)
T. aspis (Nilsen)
T. incisa (Ternetz)
Family Conochilidae
Conochilus hippocrepis (Schrank)
C. dossuarius (Hudson)
Family Filiniidae
Filinia limnetica (Zacharias)
Suborder Collothecadea
Family Collothecidae
Collotheca coronetta coronetta (Cubitt)
C. ornata ornata (Ehrenberg)
C. hoodii (Hudson)
C. paradoxa Weber
Family Flosculariidae
Ptygura intermedia Davis

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The Intestinal Flora of *Notropis cerasinus*

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Abstract—A study of the intestinal flora of the crescent shiner, *Notropis cerasinus,* entailed aseptic excision of the intestine, isolation, and identification of the specific bacterial flora. Six fish were immediately examined following collection and five after a seven day starvation. The number of bacteria appearing on the culture plates obtained from starved specimens were significantly less than those obtained from non-starved specimens. This indicated that the intestinal bacterial flora of *N. cerasinus* was determined by its recent intake of food and the degree of contamination of the ingested food and water. In all, 29 bacterial strains were isolated, and of this number, 11 genera and 19 species were identified.

Introduction

Notropis cerasinus, the crescent shiner (family Cyprinidae), is common in the upper Roanoke and Kanawha River drainages of Virginia and West Virginia. Stanger (1959) has shown its principal foods to be chironomids constituting over 50% of the analyzed stomach contents), stimuliids, trichopterans, and coleopterans. A preference for chironomids suggests that *N. cerasinus* is a riffle-bottom feeder in the Roanoke River. Stanger's is the only published study of this species other than those concerning distribution.

General opinion today (Margolis, 1953; Mattheis, 1964) holds that there are no common bacterial commensals in the intestines of fish, and that the presence of bacterial flora depends solely upon the recent intake of food and the degree of contamination of the food and water. Since there has been no previous research on the intestinal flora of *N. cerasinus*, this report documents the qualitative composition of the intestinal flora of *N. cerasinus*, and tests the effect of recent food intake on that intestinal flora.

Methods

Eleven crescent shiners were used in this study. They were collected in the Roanoke River, 5 miles west of Salem near Glenvar on February 20 and March 5, 1978 with a $15' \times 4' \times 3/16''$ seine.

Six of the fish were examined for intestinal bacteria immediately following collection. Five of the fish were starved in aerated containers for seven days prior to making cultures of the intestinal contents.

The fish were opened aseptically after swabbing the external surface of the fish with 95% ethanol. Using sterile scissors, the abdomens were opened down the midline from the pectoral fins to very near the anus, with two transverse incisions being made to allow easy access to the intestine. The intestine, distal to the stomach, was then excised, placed into a sterile petri dish

using sterile forceps, and measured. The intestine was slit and divided into 3 segments from anterior to posterior. Samples of the intestinal contents were obtained from each section by inserting a sterile bacteriological needle through the intestinal segment to remove the intestinal contents. The intestinal contents were then aseptically streaked onto nutrient agar, EMB agar, and blood agar plates with a sterile bacteriological wire loop. Then, the intestinal segments were mashed and aseptically streaked onto nutrient agar, EMB agar, and blood agar. This inoculation procedure insured transfer of any bacterial types that were attached to the intestinal villi. The inoculated plates were incubated aerobically at room temperature ($23 \pm 3°C$) for up to two weeks until enough growth for transfer to other media was found to be present.

Individual colonies were aseptically transferred from the original streak plates to new media (nutrient agar and blood agar slants) in order to isolate pure cultures. These cultures were incubated aerobically at $23 \pm 3°C$. The loop-dilution and pour plating technique (Seeley and VanDemark, 1972) were used as a means of isolating individual bacterial species from the mixed cultures. Gram stains were performed on all 14-18 hour cultures of organisms to verify the purity of the culture obtained. The following stains were used when appropriate in addition to the Gram stain: Schaeffer and Fulton Endospore stain (for Gram-positive organisms), the Capsule stain, and Sudan black B stain (to demonstrate poly-B-hydroxybutyric acid deposits in bacteria). The agar shake culture in yeast-extract/tryptone agar was used as an index of the oxygen requirements of the microorganisms.

Observations were recorded as to growth of bacterial colonies, general appearance of individual colonies, and colony characteristics. Measurements of length and width were performed on stained bacteria using a Leitz Wetzlar screw micrometer eyepiece calibrated with a Bausch and Lomb stage micrometer.

After the organisms had been isolated, the following media and biochemical tests were prepared and used to identify the micro-organisms. (All materials and media were autoclaved at 15 lb/in.^{2} for 15 minutes at $121°C$):

1) glucose, sucrose, lactose, maltose, xylose, arabinose, and mannitol broth with methyl red indicator and inverted Durham tubes to detect acid and gas formation from carbohydrate breakdown,

2) 4% peptone broth and Nessler's reagent to detect deamination of amino acids,

3) 1% tryptone broth and Kovac's solution to detect indole production,

4) urea broth in the urease test to determine the hydrolysis of urea,

5) malonate broth to test for malonate utilization,

6) gluconate broth and Benedict's reagent to test for gluconate oxidation,

7) arginine broth and Nessler's reagent to test for arginine hydrolysis,

8) nutrient broth to observe growth characteristics in the broth,

9) litmus milk for observation of fermentation, proteolysis, and reduction (Seeley and VanDenark, 1972),

10) starch agar plates to detect the diastatic (starch-hydrolyzing) action of the organisms,

11) skim milk agar to detect casein hydrolysis,

12) nutrient gelatin to test for gelatin hydrolysis,

13) 0.75% nutrient agar deeps to determine motility,

14) lead acetate agar stab cultures to detect H_2S production,

15) yeast-extract agar slopes, nutrient broth, and 3% H_2O_2 for determination of catalase activity,

16) Methyl Red-Voges Proskauer (MRVP) medium, alpha napthol solution (5% solution in alcohol), 40% KOH solution containing 9.3% creatine to test for acetylmethylcarbinol and acid production,

17) nutrient-agar plates and p-aminodimethylaniline for the oxidase test, demonstrating the presence of cytochrome c,

18) citrate medium and KCN medium to determine the presence/absence of growth,

19) nutrient agar slopes to observe growth on agar slopes and cultural characteristics such as pigment formation.

Table I. Identifying Characteristics of 19 Bacterial Strains from the Gut of Freshly Caught N. cerasinus.

Key to tests in Table I:

a = diffusable yellow water-soluble pigment produced
b = non-diffusable yellow pigment produced
c = determined using a UV lamp
d = surface violet ring from pellicle
e = dull, wrinkled pellicle
t = turbid
+t = very turbid

s = sediment
+s = heavy sediment
p = pellicle
A = acid production
G = gas production
( ) = slowly
7 = in seven days

0 = no growth
pr. = proteolysis
alk. = alkaline
red. = reduction
± = variable
$\bar{x}$ = with green metallic sheen

Isolate #	Glucose	Lactose	Sucrose	Maltose	Xylose	Arabinose	Mannitol	4% Peptone	Litmus milk	Gelatin	Methyl red	Voges Proskauer	1% Tryptone	Nutrient broth	Malonate	Gluconate	H2S	Starch Hyd.	Casein Hyd.	Arginine Hyd.	Oxidase	Catalase	Urease	Motility	EMB	Citrate	KCN	Length (uM)	Width (u?)	Gram Stain
1.	A	-	-	-	-	-	-	-	+	pr	+	-	-	-	t	-	-	-	-	+a	+	+	-	-	+	+	-	-	1.6	0.7	-
2.	A	-	-	-	A	A	A	-	-	0	-	-	-	-	t	-	-	-	+	-	-	+	-	-	+	+	-	-	3.4	0.6	+
3.	-	0	0	0	0	0	0	+	alk	-	-	-	-	+t	-	-	-	-	-	-	+	-	-	+	+	-	-	2.1	0.4	-
4.	A	-	-	-	-	-	-	+	pr	+	-	-	-	t	-	-	-	-	+a	+	+	-	-	+	+	-	-	2.3	0.7	-
5.	A	0	0	0	0	0	0	+	alk	-	-	-	-	+t	-	-	-	+	-	+	-	-	+	+	-	-	1.5	0.5	-
6.	A	-	-	0	0	0	0	+	alk	+	-	-	-	tp	-	-	-	-	+b	+	+	-	-	+	+	-	-	2.8	0.8	-
7.	A	0	0	0	0	0	0	+	alk	+	-	-	-	tp	-	-	-	-	-b	+	+	-	-	+	+	-	-	1.2	0.6	-
8.	A	-	-	-	-	-	-	+	0	-	-	-	-	tp	-	-	-	-	-b	+	+	-	-	+	+	-	-	1.8	0.7	-
9.	A	0	0	0	0	0	0	+	0	+	-	-	-	tp	-	-	-	-	-b	-	+	-	-	+	+	-	-	1.3	0.8	-
10.	A	-	0	-	-	-	-	-	alk	-	-	-	+	t	-	-	-	-	-	-	+	+	-	+	-	-	1.9	1.2	-
11.	A	0	0	0	0	0	0	+	alk	+	-	-	-	t	-	-	-	-	-	+	+	-	-	+	+	-	-	2.1	0.6	-
12.	A(G)	A(G)A(G)	A(G)	-	-	-	-	pr	+	-	+	-	ts	+	+	±	+	+	-	-	-	+	+	-	-	1.5	0.8	-
13.	AG	(AG)	AG	AG	-	-	-	+	red	(+)	-	+	-	tps	+	+	±	+	+b	-	-	-	+	+	+	+	+	2.5	0.9	-
14.	AG	A	AG	AG	-	-	-	+	pr	+	-	-	+	tps	-	-	±	+	+	+	+	+	-	+	+	-	-	2.3	1.1	-
15.	AG	A	A	AG	-	-	-	+	red	+	-	+	+	tps	-	-	+	+	+	-	-	+	+	+	-	-	2.1	0.5	-
16.	AG	A	(AG)	-	-	-	-	+	alk	+	+	0	+	ts	-	-	+	-	+	-	+	+	+	+	-	-	2.2	0.6	-
17.	A	-	-	A	-	-	-	-	0	+7	-	-	+	pd	-	-	-	-	+	-	+	+	-	+	+	-	-	2.8	0.9	-
18.	G	AG	AG	AG	-	-	-	-	-	-	+	-	+	t+s	-	-	-	+	-	-	+	-	+	+*	-	-	2.1	0.5	-
19.	-	-	-	-	-	-	-	-	red	+	-	+	-	pe	-	-	-	+	+	-	-	+	-	+	-	+	+	1.7	0.8	+

(Table I continued)

Other Observations

Isolate #	Organism
1. diffusable fluorsescent pigments[c]; obl. aerobic; short rods, singly & in prs.	Pseudomonas sp.
2. poor, thin growth on nutrient agar; fac. anaerobe; medium rods, singly & in prs.	Bacillus circulans
3. colonies opaque to white; aerobic; med. to short rods, singly & in short chains	Alcaligenes eutrophus
4. diffusable fluorescent pigments; aerobic; short rods, singly & in prs.	Pseudomonas sp.
5. colonies cream-white; aerobic; short, thin rods, mostly single	Alcaligenes faecalis
6. non-fluorescent pigment; aerobic; medium rods, singly & in short chains	Pseudomonas sp.
7. non-fluorescent pigment; aerobic; short rods, singly & in prs.	Pseudomonas sp.
8. non-fluorescent pigment; aerobic; med. to short rods, singly & in short chains	Pseudomonas sp.
9. no endospores; aerobic; short, thin rods, singly & in short chains	Flavobacter rigense
10. smooth, white to opaque colonies; no poly-B-hydroxybutyrate inclusions present; aerobic; short, plump rods, singly & in prs.	Acinetobacter sp.
11. opaque colonies; aerobic; short rods, singly & in chains	Pseudomonas sp.
12. white to opaque colonies; aerobic; med. to short bacilli, singly & in prs.	Serratia marcescens
13. opaque to white colonies; aerobic; medium rods, singly & in short chains	Enterobacter cloacae
14. smooth, round convex colonies; fac. anaerobe; medium rods, singly & in prs.	Aeromonas punctata punctata
15. cream-colored colonies; aerobic; swarming noted	Proteus vulgaris
16. cream-colored colonies; aerobic; swarming noted	Proteus mirabilis
17. smooth colonies; violet pigment; fac. anaerobe	Chromobacter violaceum
18. convex, glistening, entire, cream-white to grey colonies; fac. anaerobe; medium rods occurring singly & in prs.	Escherichia coli
19. round, opaque to white colonies; presence of endospores; aerobic; medium rods, singly & in chains	Bacillus subtilis

The media for the biochemical tests were aseptically inoculated with the specific microorganisms and incubated from 1-7 days (depending on the specific test) at $23+3°$C. All tests were performed in duplicate. After results were obtained from the biochemical tests, the organisms were keyed out to genus and species according to Bergey (1974).

Results

Abundant bacterial growth was obtained on all plate cultures of the intestinal contents of the fish examined immediately following collection. In these fish, undigested food was found to be present in the intestine. Each plate contained between 150 and 440 colonies. Twenty-nine bacterial strains were isolated from the gut flora of the 6 freshly-caught *N. cerasinus,* and of this number, 19 species and 11 genera were identified on the basis of their morphological and physiological characteristics.

As is illustrated in Table I, isolates 18 and 5 occurred in 5 and 4 fish respectively; isolates 3, 9, and 12 occurred in 3 fish; isolates 4, 7, 19, 13, 14, 15, and 19 in 2 fish; and isolates 1, 2, 16, and 17 occurred in only one fish each.

Thus it can be seen that the intestinal flora was composed of a variety of species of both indigenous aquatic bacteria and those species which are not commonly associated with the aquatic environment, but which may, under suitable conditions, multiply in water.

Cultures of the contents of the intestines of the five starved individuals also showed the presence of *Pseudomonas.* Each specimen contained only one species representing isolate numbers 1, 4, 6, 8, and 11. Also found were *Escherichia coli* (in 2 fish), and *Proteus mirabilis* (in one fish). As there was no food present in the gut, the samples consisted mainly of mucus, which was always present. The number of colonies appearing on the culture plates varied from 12 to 43.

Discussion

Though certain strains of *Escherichia coli* were frequently found in the intestines of *N. cerasinus,* it is assumed that the typical fecal types indigenous to homoithermic animals did not belong to the normal flora of the fish. Their occurrence may indicate that the animals, before having been caught, were in sewage-contaminated water.

Mattheis (1964) isolated and identified 204 bacterial strains of the genera *Pseudomonas, Aeromonas, Escherichia, Aerobacter,* and *Paracolobactrum* from the guts of 24 rainbow trout, 7 river trout, and 13 carp. Our findings paralleled his results concerning genera and species.

Apparently the kind of food that *N. cerasinus* consumes has considerable influence on its intestinal flora.

After prolonged starvation, bacteria, although few in numbers and in species, could still be demonstrated in the empty intestine, although this was a comparatively small number of colonies in contrast to the number that appeared on the culture plates of similar samples taken from non-starved, actively feeding fish. Margolis (1953) reported similar findings concerning the number of the bacterial colonies obtained from the intestine of actively feeding versus non-feeding trout and bullheads. He concluded that bacteria do not usually persist in the intestine of fasting fish.

Obst (1919) observed that of 94 herring *(Clupeus harengus)* taken off the coast of Maine, with no visible food in the alimentary tract, only 13 had bacteria in the stomach or intestine. Gillespie (1898) noted that the guts of certain fishes were free from bacteria in the absence of food. Hunter (1920) found the stomachs and intestines of spawning salmon to be sterile. Those salmon returning to fresh water to spawn do not feed, hence the digestive tract is free from food. Blake (1935) examined 22 salmonid individuals in which there was apparently no food in the digestive tract. In 15 of these, either the intestine, stomach, or both were free from bacteria. Of the remaining seven fish, Blake believed that four had digested the last of their food very shortly before examination. Other authors found no bacteria at all in the empty intestines of various fish (Mattheis, 1964).

The intestinal bacterial flora of *N. cerasinus* is apparently determined by the recent intake of food and the degree of contamination of the ingested food and water. Whether the isolated and identified bacteria are commensals, mutuals, or transients contributing to the breakdown of nutrients in the intestines of the minnows is not yet clear.

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Regarding the Validity of the Endpoint Response of the Mouse (McKenzie) Bioassay for Thyroid Stimulating Hormone

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Abstract—The release of radiolabelled thyroid hormone into the circulation in female Swiss-Webster mice has been used extensively as a bioassay for thyroid stimulating hormone (TSH). However, the specificity of several bioassays of pituitary hormones have been subject to question. Consequently, the validity of the assay endpoint for TSH in the mouse was re-evaluated with respect to the effect of luteinizing hormone (LH) whose chemical composition closely resembles that of TSH. Mice, prepared for bioassay of TSH received injections of purified LH or alpha or beta subunits of LH. Identical doses of LH and LH subunits were quantified by LH and TSH radioimmunoassays and the results compared with those obtained by the bioassay. Microgram quantities of LH and subunits of LH elicited appreciable responses in the TSH bioassay but produced only negligible effects in the TSH radioimmunoassay. The response of the TSH bioassay of LH and alpha or beta subunits of LH was 40-56% that obtained with LH radioimmunoassay. However, the pituitary concentrations obtained by TSH bioassay when compared with those obtained by radioimmunoassays for TSH, LH, or Growth Hormone (GH) paralleled closely the TSH radioimmunoassay data, although in terms of quantitative estimates, there was a 15-fold discrepancy between the TSH assays. Estimations of pituitary concentrations of LH lead to the conclusion that, at the doses normally employed, most crude rat pituitary extracts do not contain sufficient quantities of LH to alter significantly bioassayable (McKenzie) estimates of TSH.

Introduction

The secretion of radiolabelled hormone from the thyroid gland into the blood stream of the female Swiss-Webster mouse has been used extensively as an endpoint in a bioassay for thyroid stimulating hormone (TSH) (McKenzie, 1958, 1960; Bakke, 1965; van Rees, 1966; Sinha & Meites, 1966; Solomon & McKenzie, 1966). The advent of the radioimmunoassay has largely supplanted the various bioassays for the quantitation of TSH in pituitary or blood. However, the McKenzie bioassay for TSH still is being used in cases where information concerning biological activity is deemed necessary (Harada, *et al.,* 1979; Ochi, *et al.,* 1979; Rousset, *et al.,* 1977). Past studies have explored the mechanisms of this bioassay (Florscheim *et al.,* 1970) and examined the effect of TSH in plasma and pituitary extracts (Rerup & Melander, 1965; Hershman, 1970). However, a test of the specificity of this bioassay, particularly with respect to the effect of luteinizing hormone (LH) has not been performed. This is necessary since traces of LH are commonly associated with TSH prepared from pituitary extracts. Moreover, the primary structures of these two glycoprotein hormones are quite similar and it has been reported that their alpha and beta chain can combine

in vitro to form hybrid molecules which retain some TSH biological activity (Liao & Lierce, 1970; Pierce, 1971; Pierce et al., 1971a.; Pierce et al., 1971b; Cornell & Pierce, 1973). The present study, therefore, was conducted so as to determine the extent to which LH and its molecular subunits stimulate release of radiolabelled thyroid hormone into the circulation of the mouse. The responses obtained were compared to those of a specific and sensitive radioimmunoassay that utilized highly purified bovine TSH as the reference preparation and antiserum to bovine TSH (Reichlin, *et al.,* 1970.

Materials and Methods

Preparation of Hormone Solutions for Assay

The TSH contaminant was absorbed from an LH preparation (NIAMD rat LH S-1) with an antiserum to bovine TSH as previously described (Ching, 1974). Standard and test solutions of rat LH (NIAMD RP-1) and alpha and beta subunits of bovine LH (NICHHD, WRR-1α/A and WRR-2β/B) were prepared using phosphate buffered saline (PBS, 0.01 M PO_4 + 0.15 M NaCl), pH 7.5 as diluent. Concentrations of rat LH, ovine α LH and B LH were prepared for bioassay (20 ug/ml) and radioimmunoassay (50 ug/ml). Bovine TSH for use in the bioassay (NIAMD B6, 2.54 USP U/mg) and radioimmunoassay had a potency of 20-30 USP U/mg and was a gift from Dr. John Pierce. It was dissolved in a Na_2CO_3 solution, pH 10, then diluted 20-fold with saline so as to reduce the pH to 7.5.

Anterior lobes, obtained from rats 4 weeks after ovariectomy, between the 18th-20th day of gestation or after the first week of lactation, were weighed then homogenized individually in 1 ml of 0.05 M phosphate buffer, pH 7.5 containing 1% bovine serum albumin. Following refrigerated centrifugation at 1500 x g, the clear pituitary supernatants were stored at -20° C.

Preparation of Bioassay Recipients

The TSH and LH preparations and the subunits of ovine LH were tested for their effects on a bioassay for TSH (McKenzie, 1958, 1960) that utilized as recipients female Swiss-Webster mice weighing 13-15 g at onset. Pellets of a low iodine diet (Nutritional biochemicals Corporation (NBC), Cleveland, Ohio) and distilled water were provided *ad libitum.* After 10 days the mice

were each injected intraperitoneally (ip) with 3 µci ^{125}I followed 1 hour later with a subcutaneous (sc) injection (nuchal region) of 10 µg of the sodium salt of 1-thyroxine (T_4, NBC). Two days later 10 µg T_4 was again administered to maintain the suppression of endogenous TSH release. The following day the animals were used as bioassay recipients.

Bioassay Protocol

Five minutes before the removal of the first blood sample and injection of hormone or test substance, mice, serving as recipients in the TSH bioassay, were warmed under an incandescent lamp in order to dilate their tail veins. Animals were removed one by one from the warming chamber and 50 µl blood obtained by puncture of a retro-ocular, sinus using a Drummond microcap pipet; the blood was diluted in 0.5 ml distilled water contained in a 10 x 75 mm disposable glass tube. The mouse was placed in a restraining chamber and 0.25 ml of saline, hormone or test solution injected into a tail vein. Hormone solutions were administered in a volume of 0.25 ml at doses depicted in Tables 1 and 4, whereas pituitary extracts were diluted with PBS so that the dose administered was 1/250 of the gland per 0.25 ml. The time that elapsed between the collection of the blood and the intravenous (iv) injection was 1 minute. After 2 hours a second sample of 50 µl blood was removed from either the same or the opposite retro-ocular sinus. The release of radiolabelled thyroid hormone elicited by administration of the test sub-stance was determined by measuring the increase in blood radioactivity which was then related to a standard curve and equivalence in bovine TSH estimated.

TSH, LH and GH Radioimmunoassays

Test doses of purified LH and LH subunits were quantified by radioimmunoassays for LH (Niswender et al., 1968, 1969) and TSH (Reichlin et al., 1970) to determine the extent to which they cross reacted with TSH antiserum. Radioimmunoassays were also employed to measure concentrations of TSH, LH and GH (Schalch & Reichlin, 1966) in crude pituitary extracts of Sprague Dawley female rats. The fraction of pituitary assayed per tube were as follows: TSH, 50 µl of 1/100 anterior pituitary (AP); LH, 50 µl of 1/150 AP; GH, 50 µl of 1/4000 AP. These data were compared with quantitative estimates obtained by the TSH bioassay.

Results

Comparison of the TSH Bioassay and Radioimmunoassay

The release of radioactive thyroid hormone into the circulation of the mouse followed a characteristic rectilinear log-dose response to TSH. However, the vagary of the bioassay was evident when the index of inherent precision (λ) test (Cornfield, 1970) was applied (Table 1). The average λ for all doses was 0.227 which is within the limits of acceptability for bioassays.

TABLE 1

Bioassay standard curve for thyroid stimulating hormone (TSH) (NIAMD B6) expressed as increase in blood radioactivity per dose of TSH. The data represent the means ± SD of 5 recipients at each point. The formula for the stepwise multiple regression line calculated by the method of least squares (Stanley, 1963) is y = b+m log x = 2749.0 + 1476.3 log x where b is the intercept, m is the slope and x is the dose of TSH in mU. The inherent index precision (λ) = SD/m (Cornfield, 1970). The average λ was 0.227.

Dose of TSH (ng)	(mU)	Change in blood radioactivity (cpm) (mean ± SD)		y	λ
0	0	−6 ±	28	−−	−−
80	0.2	94 ±	36	55.9	0.024
160	0.4	427 ±	160	498.8	0.108
320	0.8	946 ±	391	941.7	0.264
640	1.6	1440 ±	437	1384.6	0.296
1280	3.2	1978 ±	483	1827.5	0.444

TABLE 2

Radioimmunoassay standard curve for thyroid stimulating hormone (TSH) expressed as percent radiolabelled TSH bound to homologous antibody at varying concentrations of non-radiolabelled antigen; means of duplicate values in the % bound column. The reference preparation of bovine TSH from Dr. John Pierce had a bioassay potency (Chick thyroid p[32] uptake) of 20 - 30 USP U/ mg and the antibody to bovine TSH from Dr. Si Reichlin was used at a dilution of 1:15,000. $y = b + m \log x = 91.7 - 47.8 \log x$. The average λ of the valid portion of the curve was 0.045. See heading of Table 1 for additional information.

TSH (ng)	% Bound/Total (mean $\pm$ SD)	y	λ
0	63.4 $\pm$ 2.0	--	--
3.125	58.3 $\pm$ 2.1	--	--
6.250	56.9 $\pm$ 2.8	57.9	0.065
12.500	47.2 $\pm$ 2.8	45.1	0.065
25.000	31.2 $\pm$ 1.3	32.3	0.030
50.000	19.4 $\pm$ 1.0	19.4	0.023

In the TSH radioimmunoassay, increasing log doses of nonradioactive TSH progressively displaced radioactive TSH tracer from the antibody binding sites (Table 2). In contrast to the bioassay, the λ at each dose was minute, the average λ being only 0.046 which is well within the range of acceptability. This measure of precision illustrates the superiority of a radioimmunoassay over a bioassay in terms of ability in measuring minute differences in hormone concentration. It should be noted also that the sensitivity of the TSH radioimmunoassay was 25 times that of the bioassay (Tables 1 and 2).

LH Radioimmunoassay

The precision and sensitivity of the radioimmunoassay was ilustrated once more in the standard curve for LH (Table 3). The average inherent λ of all dose standards was 0.045 which is similar to that of the TSH radioimmunoassay.

Testing the Specificity of the TSH Bioassay

As might be expected, purified LH exhibited far greater binding affinity (83%) for LH antiserum than for the heterologous bovine TSH antiserum (Table 4). One-way analysis of variance (ANOVA) revealed considerably less α and β LH subunits bound to LH antiserum, precipitation was nevertheless still greater with this antiserum than with the heterologous antiserum to TSH (p < 0.001). In the latter case, LH or subunits of LH were either undetectable or barely detectable by TSH radioimmunoassay (Table 4). Para-

doxically, equivalent doses of LH or LH subunits evoked significant increased in blood radioactivity in the mouse (p < 0.001 for LH; p < 0.05 for a LH). However, LH and subunit LH activities when assessed by the mouse bioassay were 40%-56% of that assessed by LH radioimmunoassay and actual quantities of LH measured were different (Table 4).

Assay of Anterior Pituitary Extracts

Concentrations of TSH, LH and GH in pituitary extracts of intact, ovariectomized, pregnant and lactating rats were determined by bioassay and appropriate radioimmunoassays. Quantitative estimates from the bioassay were 15 times greater than that obtained from radioimmunoassay (Table 5). However, when evaluated from the standpoint of change from the intact normal condition, the values obtained by the 2 TSH assays more closely paralleled one another than those of the LH or GH assays (Table 5).

Discussion

The results of Table 4 suggests a dose of 5000 ng LH has the same effect as 1625 ng TSH in eliciting release of radiolabelled thyroid hormone in the mouse. This is not particularly surprising in view of the finding that TSH and LH molecules, of human and cattle, consist of 2 chemically similar polypeptide chains (Pierce, 1971; Pierce et al., 1971b; Cornell & Pierce, 1973). Indeed biochemical studies suggest that the CI or alpha chains of LH and TSH of cattle possess identical

TABLE 3

Radioimmunoassay standard curve for luteinizing hormone (LH) expressed as percent radiolabelled LH bound to homologous antibody at varying concentrations of non-radiolabelled LH reference preparation (NIAMD RP-1) y = b + m log x = 25.7 - 11.4 log x. The average λ of the steep rectilinear portion of the curve was 0.034. See heading of Table 1 for additional information. Means of duplicate values in the $\%$ bond column.

LH (ng)	% Bound/Total (mean ± SD)	y	λ
0	27.0 ± 1.4	--	--
1	24.3 ± 0.2	--	--
2	22.5 ± 0.1	22.3	0.008
4	19.0 ± 0.5	18.9	0.043
8	15.2 ± 0.2	15.5	0.017
16	12.0 ± 1.4	12.1	0.122
32	8.0 ± 0.1	8.6	0.008
64	4.8 ± 0.1	5.2	0.008
128	3.8 ± 0*	--	--

* SD < 0.05

amino acid sequence and 3-dimensional configurations (Pierce, 1971; Pierce et al., 1971a) and that the primary, secondary, and tertiary structures of the beta chians, while not identical, were similar (Pierce, 1971). It was not surprising, therefore, that restoration of bioassayable thyrotropin activity occurred when the beta chain of TSH was combined with the alpha chain of LH as compared with activity elicited by either polypeptide chain (Pierce, 1971; Pierce *et al.,* 1971b). Thus, this introduced the possibility that, because of the close relationship of the chemical nature of LH and TSH, either glycoprotein hormone could be recognized by the other's biological receptors. Recent studies have demonstrated the presence of gonadotropic hormone alpha and beta subunits within pituitary extracts and sera and further that an LH preparation, free from TSH, stimulated the endpoint response of a bioassay for TSH (Hagen & McNeilly, 1975; Ching, 1974). The present study also suggests that microgram quantities of LH are able to elicit a significant endpoint response in the mouse thus demonstrating the non-specificity of this TSH bioassay (Table 4). Although FSH possesses a common alpha subunit with that of TSH and LH and a hormone-specific beta chain

(Pierce, 1971), the testing of rat FSH subunit cross reactivity was not included in this study simply because these materials were not readily available.

In view of this finding the more appropriate concern should be whether or not pituitary extracts, at dilutions normally employed in the McKenzie bioassay, contain sufficient concentrations of LH to stimulate enough secretion of radiolabelled thyroxine to impair the reliability of the bioassay. To answer this question, bioassay and radioimmunoassay were employed to quantitate TSH, LH and GH in the same crude pituitary extracts of female rats physiologically manipulated to bring about changes in pituitary contents of LH (Table 5). GH was included for study because, although it is chemically unlike TSH or LH, it is abundant in the pituitary gland and has been shown to possess some potentiating ability on another TSH bioassay whose endpoint is the thyroid gland's uptake of [131]I (Evans *et al.,* 1958; Ching *et al.,* 1975).

Calculations reveal, utilizing the data provided in Table 5, that the dose of LH administered to recipient mice would not exceed 200 ng LH even at the higher anterior lobe weights of 15 mg. According to Table 4, this dose of LH is not able to stimulate an endpoint

TABLE 4

Comparison of quantitative estimates by thyroid stimulating hormone (TSH) bioassay and TSH and luteinizing hormone (LH) radioimmunoassays of test doses of rat LH (NIAMD LH S-l) and ovine LH alpha and beta subunits (NICHHD WRR-l α/ A and WRR-l β/ B. Shown are the means ± SD of 4 - 6 determinations per point. ND = nondetectable.

Dose (ng)	TSH Concentration (ng)		LH Concentration (ng)
	Bioassay	Radioimmunoassay	Radioimmunoassay
0	ND	ND	ND
450 LH	69 ± 87	ND	--
750 LH	79 ± 58	ND	--
5000 LH	1625 ± 308	ND	4082 ± 39
5000 α LH	81 ± 59	3 ± 1	144 ± 104
5000 β LH	110 ± 141	1 ± 0*	273 ± 122

SD < 0.05

TABLE 5

Concentration in nanograms per milligram wet weight of bioassayable thyroid stimulating hormone (TSH) and radioimmunoassayble TSH, luteinizing hormone (LH), and growth hormone (GH) in pituitary extracts of intact normal controls (NC), ovariectomized (O), pregnant (P) and lactating (L) Sprague-Dawley rats. Shown are the means ± SD of 6 determinations per point. The percent of change from normal are shown within brackets.

Group	Bioassay TSH	Radioimmunoassay TSH	LH	GH
NC	4100 ± 3300 (100%)	300 ± 100 (100%)	460 ± 150 (100%)	7300 ± 1300 (100%)
O	3600 ± 1300 (88%)	240 ± 30 (80%)	1770 ± 880 (385%)	10700 ± 1500 (146%)
P	2200 ± 800 (54%)	150 ± 20 (50%)	3250 ± 1000* (706%)	8000 ± 1300 (110%)
L	3600 ± 1600 (88%)	80 ± 10 (27%)	620 ± 20 (134%)	2700 ± 1200* (37%)

*p < 0.05 when compared to its NC value

response in the mouse with the exception of Group L, the close parallelism of the radioimmunoassay and bioassay of TSH in the same rat pituitaries, in which LH was quantified, lends support to the notion that the estimations of TSH concentrations by the McKenzie bioassay evidently were not altered by LH present in the pituitary extracts. Other investigators, employing radioimmunoassay (RIA) or bioassay (OAAD), also report concentrations of LH in pituitary that are too low to sufficiently stimulate the TSH bioassay. Calculations from data of Gay & Midgley (1969) reveal that no more than 172 ng LH (RIA male rat pituitaries) would be administered to mouse recipients. Similarly only 112 ng LH (OAAD) from proestrous rat pituitaries would be injected into mice (Bradshaw & Critchlow, 1966). Anderson & McShan's (1966) study show that a mere 128 ng LH (OAAD) would be administered, based on equivalent fractions of anterior pituitaries from ovariectomized rats; even smaller doses of LH would be obtained in other phases of the estrous cycle.

The experiments of Niswender *et al.,* (1968) show some pituitary concentrations of LH to be of sufficient intensity (20 ug - 64 ug, RIA or OAAD), even after a 250-fold dilution and theoretically would stimulate thyroidal release of thyroxine in the mouse. However, LH concentrations in rat sera (Niswender *et al.,* 1968) or ovine sera (Niswender *et al.,* 1969) are too minute (<90 ng/0.25 ml) to stimulate the TSH bioassay. Thus it appears that although some confusion exists as to whether or not pituitary concentrations of LH are sufficiently high to significantly alter true estimates of TSH when assayed in the radioiodined-primed mouse, the majority of evidence suggest that the hormone levels are too low to be of much consequence. Certainly, this is true of the circulating levels of LH in rats and sheep. As Table 5 suggests, glandular changes in GH concentration do not appear to alter in obvious fashion the estimates of the TSH bioassay. However, interpretations of this kind are not without risk since crude pituitary extracts contain other hormones, any number of which could stimulate or inhibit the endpoint response of the McKenzie bioassay for TSH.

Although an attempt was made to minimize the stressing of the mice through undue restraint, surgery or warming, it is impossible to eliminate these insults entirely nor was it desirable to do so since stress of the recipients are an unavoidable part of the McKenzie bioassay. After all, this was an inquiry into the reliability of this bioassay's endpoint response to test substances which indeed is thought to be influenced by stress (Sowers, *et al.,* 1977; Sterling & Lazarus, 1977). There is ample evidence that short term immobilization, surgery, either anesthesia or other stresses decrease pituitary secretion of TSH in animals and man (Sowers *et al.,* 1977; DuRuisseau *et al.,* 1978; Sterling & Lazarus, 1977) as well as alter the secretion of GH and LH (Sowers *et al.,* 1977; DuRuisseau *et al.,* 1978; Krulich *et al.,* 1974; Schalch & Reichlin, 1966) which indirectly influence thyroid gland activity (Evans *et al.,*

1958; Ching, 1974; Ching *et al.,* 1975). However, the reduction of TSH secretion by the pituitary of the mouse recipient as a result of stress would be of little consequence in the McKenzie assay since supranormal doses of T_4 are administered in order to suppress endogenous TSH release. Rather, the more appropriate concern should be what modulatory effect stress has on thyroid activity. Sowers *et al.,* (1977) reported that serum T_3 titers were depressed in humans 10 minutes after surgery and presumably stress does suppress some thyroid hormone release in the mouse recipient in the McKenzie TSH bioassay. However, judging by the good correlation of radiolabelled thyroid hormones released into the blood in response to stepwise increments of administered TSH (Table 1) it would appear that the stresses to which the mice had been subjected, did not alter the endpoint of the assay sufficiently to compromise its veracity.

Acknowledgements

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Contributions to the Reproductive Biology of the Eastern Pirateperch, *Aphredoderus sayanus*

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Abstract—The reproductive system (including ovarian and testicular development) of *Aphredoderus sayanus* is described. The gonads of forty-three specimens (13 male; 29 female; one undetermined) were examined histologically and a gonosomatic index (GSI—the ratio of total gonad weight to total body weight) was calculated for each individual. Gonads began to ripen in the fall, with the testes maturing sooner than the ovaries. Sperm were seen in November males while mature eggs were not detected until April 1. *Aphredoderus sayanus* is a spring spawner.

Introduction

The Eastern Pirateperch, *Aphredoderus sayanus*, of the monotypic family Aphredoderidae, is an inhabitant of coastal drainage areas along the Atlantic seaboard; however, detailed information on the biology of this fish is scarce. The most recent work was done by Parker and Simco (1975), who described some basic activity patterns of *Aphredoderus*. Martin and Hubbs (1973) briefly described some aspects of embryological development in *Aphredoderus* and Mansueti (1963) detailed the migration of the vent and urogenital pore from its early developmental position, immediately anterior to the anal fin, to the jugular or thoracic position in the adult. This phenomenon has been well documented by numerous researchers (Jordan and Evermann, 1896; Forbes and Richardson, 1920; Hall and Jenkins, 1954).

Aphredoderus sayanus exhibits no external sexual dimorphism; and sex determination, except during the spawning season, must be done by gross examination of the gonads. No information exists in the literature concerning the histology of the reproductive system of the Aphredoderidae. This study was undertaken to describe the micro and macro-anatomy of the reproductive system and the seasonal histological changes in the gonads of *Aphredoderus sayanus*.

Materials and Methods

Specimens for histological examination were collected from Cypress Pond, a part of the Dismal Swamp drainage, located on Rte. 642 outside of Suffolk, Virginia. Collections were routinely made on a monthly basis, but in certain months two or three samples were taken. Specimens were kept alive and transported to the laboratory at Old Dominion University.

The majority of fish were captured by using a ⅛ inch mesh seine. A dip net was used with some success along the banks of small feeder streams where there was heavy vegetation.

The overall body weight before the removal of the gonads was measured to the nearest 0.1 gm. Gonad weight was measured to the nearest 0.1 mg. The gonad weight was expressed as a percentage of the total body weight to give the gonosomatic index (GSI) (Wiebe, 1968).

All freshly killed specimens were weighed and the standard length measured to nearest millimeter. Ventral and lateral incisions were made through the body wall to form a flap which, when lifted, exposed the entire coelomic contents. The gonads were removed intact, weighed, and fixed.

Some tissues were fixed in 10% formalin; formalfixed material was generally unsatisfactory since it exhibited a great degree of shrinkage (Ross, 1953). Most of the tissue was fixed in Bouin's fluid for 8 hours, dehydrated in an ethanol series, cleared in benzene and embedded in 56° C paraffin. A majority of the tissue sections were cut 8 μm thick, but some sectioning was done at thicknesses of 6 and 10 μm. In addition, sperm smears were made by smearing testicular material directly on albuminized slides that had a few drops of Ringer's solution added to them. This was followed by fixation in 95% ethanol for 24 hours.

Most sections were stained with Harris' hematoxylin and eosin Y, whereas some were stained with Milligan's Trichrome stain to differentiate muscle and connective tissue. Sperm smears were stained in Kernechtrot-Fast green (FCF).

For some of the more advanced stages of the female ovary, the blocked tissue was soaked in a mixture of glycerin and alcohol (Bowers and Holliday, 1961) which facilitated sectioning of the yolk-laden eggs.

Measurements of maturing ovarian and testicular structures (to nearest tenth of micrometer) where made with an ocular micrometer from the slides used for histological examination. In measuring ova, only the maximum diameter was considered.

Results

Structure of the ovaries—The ovaries, lying posterior to the stomach, are paired structures which are fused dorsally and posteriorly. The ovaries are attached medially by mesentaries to the air bladder, ventrally to the urogenital canal and posteriorly to the wall of the body cavity. An abundance of fat surrounding the ovaries was seen in the females taken in the early fall

and in those specimens collected in the spring which were assumed to have spawned (spent condition). Fat was not seen in specimens which had near-ripe or ripe gonads.

The oviducts of both ovaries combined to form a single duct which leads posteriorly to the ventral portion of the urinary bladder. The urinary bladder is a clear, thin-walled sac at the most ventral and posterior portion of the cavity. The urogenital canal courses ventrally from the bladder to run alongside the intestine with both structures ending in external openings in the thoracic region. Both the vent and the urogenital pore are situated jugularly in the adult, the vent being anterior to the pore.

The ovaries are covered with a thin sheet of mesothelium below which lies the ovarian wall, the tunica albuginea. The thickness of this connective tissue structure is extremely variable during the oogenic cycle. The tunica albuginea measured 25 µm in thickness just prior to spawning (March 18th specimen), while in the post-spawned condition (April 23rd specimen) it measured 275 µm. Variation in the thickness of the tunica albuginea around a single ovary was also noted. Internally, many connective tissue lamellae project inward from the tunica albuginea to the lumen of the ovary (Fig. 1).
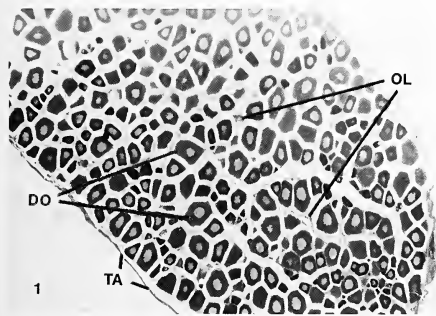

FIG. 1—Cross-section of ovary of 74mm S.L. female collected September 4, 1976, showing very early stages of development. Hematoxylineosin. 240x. Formalin fixed.

The oogonia undergo periods of multiplication, growth and maturation. The transformation of an oogonium into an oocyte is accompanied by a general growth of both nucleus and cytoplasm. The smallest oocytes were found in a September specimen and had a cellular diameter of 55 µm and a nuclear diameter of 15 µm. Nucleoli were numerous and were noted at the periphery of the nucleus. As the follicle matured, the nucleus began to lose its circular shape, becoming more irregular in outline (Fig. 2). From this stage onward, the cytoplasm increases greatly while the nucleus grows very little.

Beginning with the October-November specimens,
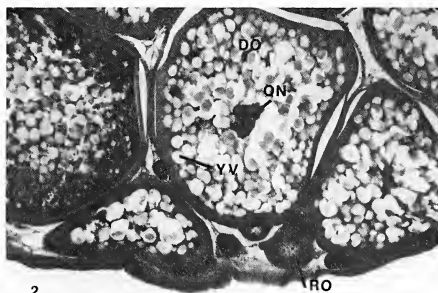
FIG. 2—Cross-section near periphery of ovary of 69mm S.L. female collected November 29, 1976, showing yolk-filled oocyte. Hematoxylin-eosin. 100x. Bouin's fixative.

there were two distinct types of oocytes readily apparent in the ovary: the maturing oocyte which had a thin layer of follicular cells around it and the resting oocyte which did not have a follicular layer (Fig. 2). The resting oocytes grow no larger and ramain at this stage throughout the rest of the ovarian cycle. In addition these resting oocytes showed no signs of degeneration and were typically more numerous than the maturing oocytes. The largest maturing oocyte at this time had a cellular diameter of 150 µm and nuclear diameter of 75 µm.

Vitellogenesis was first noted in an October specimen. Yolk deposition occurred first in the larger and more peripheral vesicles and, by November, these vesicles were noted in the region of the nucleus. Spatial sequence of yolk deposition has been cited by many researchers (James, 1946; Bowers and Holliday, 1961; Merret, 1970; Rizkalla, 1970). Outside the yolk vesicles the cytoplasm showed a number of empty vacuoles whose contents were probably dissolved during dehydration (Fig. 2).

The membranes surrounding the egg have been the subject of a great deal of controversy. Different researchers have used the terms zona pellucida, zona radiata, oolemma, chorion and vitelline membrane to describe the same structure. Ginzburg (1968) presented a strong argument in favor of the term zona radiata, which is adopted here.

Abbreviations on Plates

CL,	corpus luteum	SL,	semininferous lobule
CT,	connective tissue	SM,	smooth muscle
DO,	developing oocyte	SP,	spermatids
FN,	follicular nucleus	SS,	secondary spermatocytes
IN,	interstitium	SY,	secondary yolk
OL,	ovigerous lamellae	SZ,	spermatozoa
ON,	oocyte nucleus	TA,	tunica albuginea
PS,	primary spermatocytes	UNK,	unknown structure
RO,	resting oocyte	YV,	yolk vesicle
RSZ,	residual spermatozoa	ZRI,	zona radiata (inner)
SG,	spermatogonium	ZRO,	zona radiata (outer)

The zona radiata makes its first appearance after the beginning of yolk formation. It directly adjoins the oocyte surface and contains radial striations (pore canals) that are clearly visible at high magnifications. At first there is only one zona radiata (inner zona radiata), but a second layer (outer zona radiata) is subsequently laid down (Fig. 3). Both layers thicken as development proceeds. In the December specimen the cellular diameter measured 525 μm with a nuclear diameter of 85 μm. In this specimen an unidentified structure was seen in several areas of the ovary (Figs. 4 and 5). This structure was located between developing oocytes (Fig. 4) and consisted of a number of individual units. Upon examination at a higher magnification, each unit appeared to consist of a lumen surrounded by a stratified layer of smooth muscle-like cells, outside of which was a connective tissue covering. These units were oriented in various directions with no distinct pattern of organization. To the best of our knowledge, this structure bears no resemblance to any structure previously described in the literature (Turner, 1919; Foley, 1926; Craig-Bennett, 1930; Matthews, 1938; Weisel, 1943; James, 1946; Cooper, 1952; Gokhale, 1957; Beach, 1959; Bowers and Holliday, 1961; Stanley, Chieffi and Botte, 1965; Lambert and van Oordt, 1965; Ahsan, 1966; Moser, 1967; Merrett, 1970; Rizkalla, 1970; Bieniarz and Epler, 1976), and its functional significance is unknown. However, it could possibly be a baroreceptor functioning in the process of ovulation.
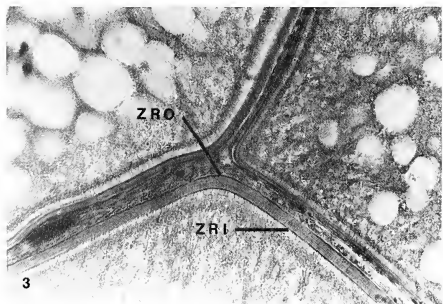
FIG. 3—Portions of three oocytes from a specimen collected December 13, 1976. Notice both the inner and outer zona radiata and also the follicular cell layer. Hematoxylin-eosin. 400x. Bouin's fixative.

There was a lack of specimens for both January and February, due to an inability to collect more than one pirateperch by seining. It has not been determined where the pirateperch dwell in the colder winter months. It was not until March 18, 1977 that another adult female was collected. This specimen (42 mm S.L.) had large yolk-filled oocytes that were still developing and, in general, her ovaries were not considerably different from the December females. The nuclei of
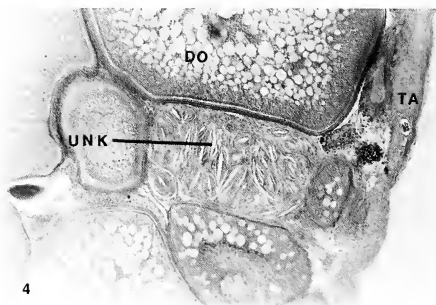
FIG. 4—Cross-section through the ovary of the specimen shown in Fig. 3. In the center is the unidentified structure which was found in several areas of the this ovary and the ovary of a different specimen. Hematoxylin-eosin. 100x. Bouin's fixative.

FIG. 5—Enlargement of structure shown in Fig. 4. The ducts were composed of smooth muscle tissue and the fibers were collagenous. Milligan's trichrome stain. 200x. Bouin's fixative.
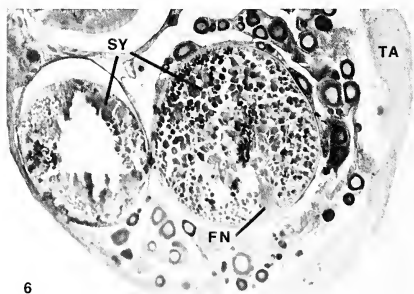
FIG. 6—A section through an ovary of a 60mm S.L. female collected April 1, 1977, showing large oocytes filled with the secondary yolk. The large follicle in the center measured 1mm in diameter. Hematoxylin-eosin. 40x. Bouin's fixative.

these oocytes were usually absent due to the great loss of follicular contents resulting from sectioning. The largest follicular diameter was 675 μm.

On April 1, 1977, a single adult female (60 mm S.L.) was collected whose ovaries were bright orange and contained large spherical eggs. The eggs had a dark orange center and a light orange cortex. The ovaries in this instance were extremely swollen, this enlargement being attributed to the growth of existing eggs. The eggs measured almost 1 mm in diameter (Fig. 6) and were found to contain an oil droplet approximately 0.3 mm in diameter, which agrees with the findings of Martin and Hubbs (1973). The yolk in these eggs stained differently from previous specimens, staining faintly reddish with eosin. A nucleus 150 μm in diameter was seen in one of these sectioned eggs (Fig. 6).

The next stage in the oogenic cycle, the spent ovary, was seen in the single adult specimen collected on April 13, 1977. The ruptured follicles of the spent ovary, which were once as big as the eggs, were collapsed and the follicular epithelium, which now represented the luteal-like cells, appeared thickened (Fig. 7). Most of these post-ovulatory follicles become transformed into corpora lutea-like structures resembling those previously reported in fishes. There was also a thickening of the tunica albuginea which now measured 275 um at its thickest point. Also most of the residual (resting) oocytes were still present in the spent ovaries.

Structure of the testes—The testes occupy the same position as the ovaries and have a similar form. The testes, fused posteriorly, are connected by mesentaries to the surrounding viscera in much the same way as the ovaries. As development proceeds the testes enlarge and gradually fill the entire cavity. In one near-ripe male, one lobe of the testes spread almost to the pericardial region.
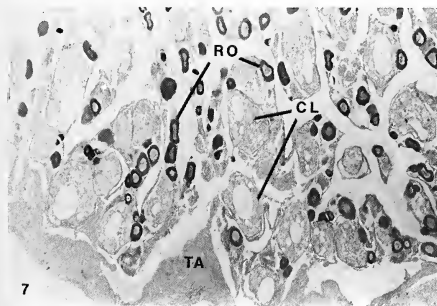
FIG. 7—A section through the ovary of an April 30, 1977, female showing numerous resting oocytes and corpora lutea. Hematoxylin-eosin. 40x. Bouin's fixative.

Each testis, covered with a connective tissue sheath, is formed of closely packed seminiferous lobules (Fig. 8). The lobules of the testes of fish are not strictly comparable with mammalian seminiferous tubules, as there is no permanent gerrminal epithelium in fish (Craig-Bennett, 1930). The germ cells are arranged in cysts within the lobules and each cyst behaves as a unit during maturation. Within any lobule germ cells in various stages of development can be found. The lobules are separated by the interstitium which consists connective tissue, vascular elements, and interstitial cells.

The first male testis studied was from an early September specimen. The testes were two thin, clear strands that, when viewed microscopically, revealed nests of germ cells and the beginning of lobule formation (Fig. 8).
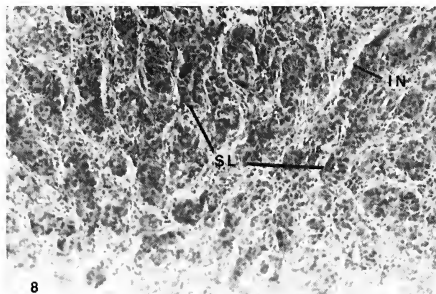
FIG. 8—Cross-section of testis of a 79mm S.L. male collected September 4, 1976, showing very early stages of development. Hematoxylin-eosin. 200x. Formalin fixed.

The next male available for study was from a November specimen, and the lobules showed all stages of spermatogenesis, including tailed sperm (Fig. 9). In these sections, four types of spermatogenic cells were distinguishable. The largest of these were the spermatogonia, which had a clear outline and a prominent nucleus. This situation was first observed by Turner (1919) and has been noticed by many other researchers (Foley, 1926; Matthews, 1938; James, 1946; and Rizkalla, 1970).

The spermatogonia of *Aphredoderus* measures between 4.5-5.5 μm. The spermatogonial nuclei were very basophilic, while the cytoplasmic matrix stained faintly with Hematoxylin-eosin.

The commencement of maturation was recognized by the appearance of the primary spermatocytes, which where the most numerous cells in the lobules. They were rounded cells having indistinct outlines, with only the basophilic nuclei taking up the stain. The nuclei of these cells measured between 2.7-3.3 μm (Fig. 9).

The transition period from primary spermatocytes to secondary spermatocytes, as well as the time requried for secondary spermatocyte division, must be very brief due to the paucity of clumps comprised wholly of

secondary spermatocytes. It is very difficult to determine with accuracy the difference between the late secondary spermatocyte stage and the early spermatid stage. However, the nuclei of the secondary spermatocytes were slightly smaller than that of the primary spermatocytes, measuring between 1.5-2.2 μm, while the spermatides were recognized by their overall small size (1.0-1.5 μm) and their deeply staining, concentrated chromatin material, which gave their nuclei a solid appearance (Fig. 9).
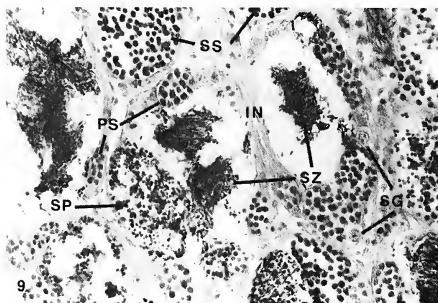
FIG. 9—Longitudinal section through the posterior portion of a testis from a 95mm S.L. male collected January 18, 1977, showing lobules densely packed with sperm. Hematoxylin-eosin. 100x. Bouin's fixative.
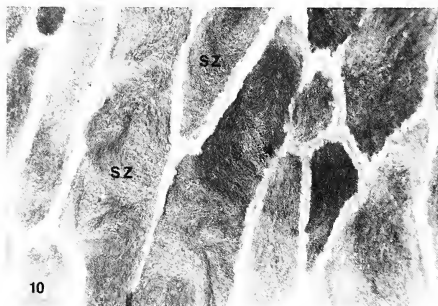
FIG. 10—Cross-section through the anterior portion of a testis from the same specimen as Fig. 9, showing all stages of spermatogenesis. Hematoxylin-eosin. 400x. Bouin's fixative. 6 μm section.

Isolated sperm could be viewed and measured from smears. The January sperm heads measured 5 μm in length with tails approximately 30 μm long. The heads tapered at the anterior end and became wider posteriorly.

At this stage the spermatozoa lay in the center of the lumen, and spermatids usually occurred in clumps around the sperm, but without clear serial arrange-

ment of cells in order of maturity. Bowers and Holliday (1961) noted a similar arrangement in the testes of the herring.

In the specimen taken in November, the lobules located more posteriorly were packed with sperm, while some of the more anterior lobules contained sperm not nearly so numerous. A specimen from December showed a decreasing number of lobules which were not packed with sperm. Many of these lobules did not contain spermatocytes or spermatids. Some of the most anterior lobules in this specimen were still lacking sperm.

In the January specimen there was a further increase in the number of lobules containing densely packed sperm (Fig. 10). Only a few of the most anterior lobules still contained spermatocytes. The abdomen in this specimen was extremely swollen, approximating spawning conditions.
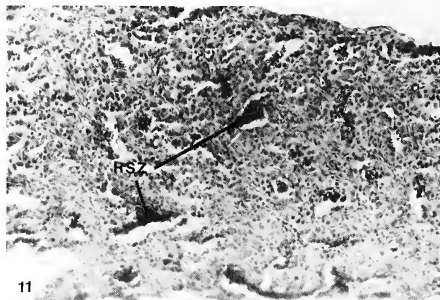
FIG. 11—A section through the spent testis of an April 23, 1977, male showing residual sperm. Hematoxylin-eosin. 200x. Bouin's fixative.

The next male that was collected had already spawned, and his testes has assumed the post-spawn condition. This specimen was collected on April 13 and his testes had the appearance of two thin clear strands. These testes differed from the testes of the early September specimen in that the residual sperm had not been resorbed (Fig. 11). In subsequent collections on April 23, April 30 and May 13, no males had testes which contained any residual sperm. These testes differed from the testes of the early September specimen in that the residual sperm had not been resorbed (Fig. 11).

Discussion

The relationship of the gonads to other internal organs in *Aphredoderus* followed the typical pattern of other teleosts. The course of gametogenesis has not been described in detail for many teleosts. However, this process in *Aphredoderus* is similar, in general, to those descriptions available. There are, of course, a number of differences between the developmental pro-

Table I.   Monthly collection data of specimens showing sex, standard
           length, total weight, gonad weight, gonosomatic index and
           average gonosomatic index.

Month	Sex	S.L. (mm)	Wt. (gr)	Gonad Wt. (gr)	GSI	Ave. GSI per collection	
1976							
Oct. 16	F	50	2.9	0.05	0.02		
	F	50	8.4	0.03	0.00	0.01	F
Nov. 9	F	73	9.5	0.26	0.03		
	F	75	13.0	0.43	0.03	0.03	F
	M	72	10.4	0.85	0.08	0.08	M
Nov. 29	F	69	9.0	0.51	0.06		
	F	76	11.2	0.51	0.05	0.06	F
	M	83	17.6	1.83	0.10	0.10	M
Dec. 13	F	81	11.0	0.41	0.04		
	F	92	19.3	0.74	0.04		
	F	78	10.5	0.36	0.03		
	F	70	7.3	0.25	0.03		
	F	44	1.6	0.05	0.03	0.04	F
	M	39	1.2	0.01	0.01	0.01	M
1977							
Jan. 18	M	95	21.5	1.28	0.06	0.06	M
Feb. 2	un-known	29	0.5	0.02	0.05	0.05	unk.
Mar. 18	F	42	1.5	0.09	0.06	0.06	F
April 1	F	60	5.3	0.11	0.02	0.02	F
April 13	M	52	3.7	0.04	0.01	0.01	M
	F	53	4.5	0.06	0.01	0.01	F
April 23	M	66	7.0	0.01	0.00		
	M	59	4.7	0.00	0.00	0.01	M
	F	67	8.9	0.18	0.02		
	F	75	10.8	0.25	0.02		
	F	55	5.2	0.10	0.02		
	F	49	3.1	0.02	0.01	0.02	F

Table I. (Continued)

Month	Sex	S.L. (mm)	Wt. (gr)	Gonad Wt. (gr)	GSI	Ave. GSI per collection	
April 30	F	94	29.0	0.22	0.01		
	F	83	17.7	0.19	0.01		
	F	73	11.5	0.14	0.01		
	F	79	12.0	0.70	0.06		
	F	67	7.3	0.04	0.01		
	F	57	5.6	0.04˙	0.01	0.02	F
May 13	F	76	12.1	0.12	0.01		
	F	56	6.1	0.05	0.01		
	F	57	6.0	0.04	0.01	0.01	F
	M	54	5.0	0.00	0.00		
	M	56	5.4	0.00	0.00		
	M	71	11.0	0.01	0.00	0.00	M

cesses in the male and the female. There is a continual production of spermatozoa within the lobules of the testis during maturation, whereas in the ovary maturation is concerned with the growth of existing oocytes. The germ cells of the ovary develop gradually with a smooth transition from stage to stage. The number of gametes produced from a germ cell differs greatly between the testis and ovary. Tailed sperm are present in the male testes as early as November, while fully developed eggs are not seen until April. The increase in size of the testis as maturity advances is a result of the increasing number of germinal cells; this contrasts with the condition in the ovary, where an increase in size of the gonad results from the increase in size of a fixed proportion of oocytes.

In assessing pirateperch according to their gonosomatic index (GSI), it is evident that the testes make up a larger proportion of total body weight in maturing males than do ovaries in the females, when compared in the same time period (Table 1). The highest GSI in a male was in a November 29 specimen whose GSI was 1.10 or 10% of total body weight. In a female the highest figure was from a March 18 specimen whose GSI was 0.06 or 6% of total weight. In both males and females there is a gradual increase in the GSI from October through November; however, in December there is a decline in the GSI. The average female GSI from December 13 is higher than November 9, but not November 29. This might be attributed to the small sample size of November 29 (two specimens). The small number of males collected could also be the

reason for the rather erratic data associated with the male GSI from the fall and early winter.

In females collected in the spring there was a fairly even decline in the GSI from a high of 0.6 on March 18, to a low of 0.01 on May 13. A similar decline was seen in the male GSI. This decline carried through the assumed spawning period of April 1-13. In the April 30 collection one female had a GSI of 0.06 which was considerably higher than any of the others examined on that date. This specimen was assumed to be "egg bound," meaning that one or both of the oviducts may have been blocked, and a large proportion of the eggs remained unshed. This condition has been observed by several authors (Beach, 1959; Bowers and Holliday, 1961; and Bieniarz and Epler, 1976).

From the examination of the gonads of *Aphredoderus* collected at various times from September through May, it can be seen that the weight and the macroscopic and microscopic appearance of both testis and ovary vary at different periods. An abundance of fat surrounding the ovaries was seen in females taken in the early fall and in those specimens collected in the spring which were assumed to have spawned (spent condition). Fat was not seen in specimens which had near-ripe or ripe gonads. Craig-Bennett (1930), in observations on *Mugil, Salmo* and *Gasterosterus,* noted a similar reduction in the amount of fat at the time of maturation of the gonadal products. He believes, however, that there is no relationship between the development of fat and sexual maturity, and that the role of the fat is probably simply that of storage of

material, reflecting food abundance.

In September the lobules of the ripening testes were in the very early stages of spermatogenesis. As spermatogenesis advanced, the testes increased in size, and large quantities of sperm were found prior to spawning. With the extrusion of sperm during spawning, the size of the testes decreased considerably.

The increase in weight of the ovaries resulted from an increase in size of eggs brought about by the addition of yolk and, consequently, after spawning there was a decrease in weight. Two types of yolk were present in the developing eggs, the first type being noted in the October specimens. The second type of yolk appeared in the eggs of the April 1, 1977 specimen. Several investigators (Matthews, 1938; Bowers and Holliday, 1961; Merrett, 1970) have noted similar changes and have termed the type of yolk found in the April 1, 1977 specimen as secondary yolk. Bowers and Holliday (1961) contend that this secondary yolk differs from the primary or precursor yolk in that is is transferred from the blood vessels of the follicle to the egg. This transfer takes place at the latest maturity stages, i.e., just prior to ovulation.

The completion of spawning was followed by the resorption of any unextruded mature eggs and the development of corpora-lutea. The corpora-lutea of *Aphredoderus* are similar to those described for other species such as *Fundulus heteroclitus* (Matthews, 1938) *Gadus merlangus* and *G. esmarkii* (Gokhale, 1957) and *Clarias lazera* (Rizkalla, 1970). While the activity of *Aphredoderus* corpora-lutea was not assessed, the corpora probably function in steroidogenesis as suggested for other teleost species (Hoar, 1965; and Lambert and Van Oordt, 1965).

The determination of spawning period was deducted from the state of the male and female gonads, the weight of the gonads in elation to the overall body weight and the approximate age of the newly hatched fry. The calculated spawning period for pirateperch was the first two weeks in April.

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Upland Hardwood Forests of Pittsylvania County, Virginia

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Abstract—A study of twenty-two upland hardwood forests in Pittsylvania County, Virginia revealed two general types of forest. White oak forests, forming one type, were fairly diverse forests with *Quercus alba* being the major dominant and with *Acer rubrum* and *Liriodendron tulipifera* often obtaining high importance. Chestnut oak forests, the second class, were much less diverse forests with *Q. prinus* beging the major dominant, and with *Q. alba* and *Q. coccinea* also attaining major importance. The forests of the latter type were generally found in poorer soils. The forests of this county resembled those previously studied in the Virginia and North Carolina Piedmont. However, *Quercus stellata*, important in Oosting's North Carolina study, and *Q. rubra*, reported as important in Gemborys's Prince Edward Co., Va. study, were both very low in importance. *Quercus coccinea*, reported to be low importance in other studies, was important in Pittsylvania Co. In general structure these forests are clearly a part of the Oak-Hickory-(Pine) Forest Region of Braun and Kuchler.

Introduction

The Piedmont of Virginia lies within the region designated by Braun (1950) and Kuchler (1964) as having oak-hickory-(pine) climax forests. This forest region covers the Piedmont Plateau and much of the Coastal Plain of the Atlantic and Gulf states, extending from Maryland and northern Virginia to as far south and west as eastern Texas. Pines are largely successional rather than climax (Oosting 1956, Braun 1950) but their abundance serves to distinguish the region from the Oak-Hickory Forest Region (Braun 1950) of the western part of the Eastern Deciduous Forest Formation. The three major successional species are *Pinus virginiana, P. echinata*, and *P. taeda*, though the latter two are absent from the northern part of the region. The major hardwood species widely distributed through the oak-hickory-(pine) region include *Quercus alba, Q. rubra, Q. velutina, Q. falcata, Q. stallata, Carya cordiformis, C. ovata, C. tomentosa*, and *C. glabra*, with *Oxydendrum arboreum, Cornus florida, Nyssa sylvatica, Acer rubrum* and *Liquidambar styraciflua* as typical subordinate species. Several other tree species may have local importance, but are not important throughout the region as are most of the above (Oosting 1956).

Studies have been made of upland hardwood forests in the North Carolina Piedmont (Oosting 1942), and Braun (1950) felt this area best exemplified the oak-hickory-(pine) climax forest region. Oosting (1942) placed the North Carolina Piedmont upland forests into two local classes of the general oak-hickory climax types. The more mesic class was characterized by *Quercus alba* and *Carya spp.*, with *Q. stellata* and *Q. velutina* also important, and the second type by *Q.*

stellata and *Q. alba*, with *Q. falcata (Q. rubra* by his nomenclature) also important. These two categories were named white oak and post oak forests, respectively. The post oak forests tended to occur in poorer soils and on drier ridges and knolls. Oosting (1942) found these two forest types to be closely related, but also found each to have distinct characteristics. Considering all these upland stands together, *Quercus alba, Q. stellata, Carya ssp., Q. coccinea*, and *Q. falcata* were the five major overstory species in order, with *Oxydendrum arboreum, Cornus florida*, and *Acer rubrum* the major understory species. *Quercus rubra* (his *Q. borealis*) was relatively unimportant, occurring in only 3.3% of the stands.

In a previous study of Virginia Piedmont hardwood forests, Gemborys (1974) examined the vegetational structure of forests in Prince Edward County, located in the south central Piedmont of Virginia. He reported the most important species in upland stands to be *Quercus alba, Q. rubra, Acer rubrum, Quercus prinus, Nyssa sylvatica, Q. falcata, Carya tomentosa*, and *C. glabra*. In sharp contrast to Oosting's (1942) findings in the North Carolina Piedmont, *Quercus stellata* was not a major species, while *Quercus rubra* and *Quercus prinus*, both unimportant in the North Carolina Piedmont, were each the leading dominant in 5 stands.

Pittsylvania Co. is in the Piedmont of Virginia, southwest of Prince Edward Co., and bordering on North Carolina. Thus it lies between the study sites of Gemborys (1964) and Oosting (1942). This paper reports on the composition of the upland hardwood forests of Pittsylvania County, analyzes interrelationships between stand compositions through an ordination model, examines possible relations between vegetational structure and environmental parameters, and compares the vegetation of this county with that described elsewhere in the Piedmont portion of the oak-hickory-(pine) forest region.

The Study Area

Pittsylvania is the largest county of Virginia, having an area of 1,015 square miles (2629 km²). It was "covered by magnificent woodland" before the settlement of the white man (Fuller *et al.*, 1925), but virtually no virgin tracts of hardwood forest remain today because of lumbering and cultivation. Because of the areal extent of the county and the development and cultivation of many areas, the stands selected were restricted to a centrally located, less developed portion
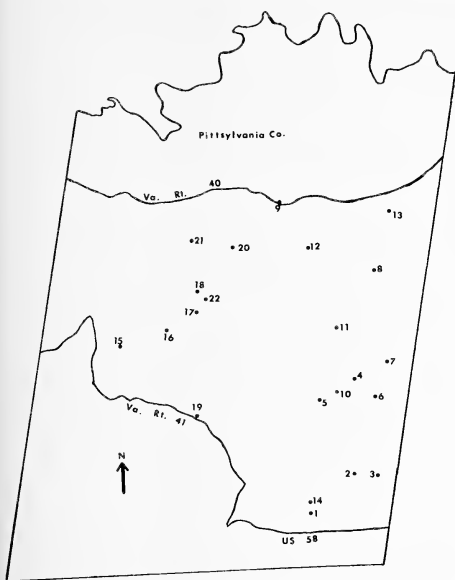
FIG. 1—Location of study sites in central and eastern Pittsylvania Co., Virginia.

of the county. This included the area of the county north of U.S. Highway 58, south of State Highway 40, and east of State Highway 21 (Fig. 1). The topography of this county is one of rolling hills, numerous streams, and generally good drainage. The upland soils are of several types, but by far the greatest percentage of them are of the Cecil series and of a sandy loam type (Fuller *et al.*, 1925).

The climate of Pittsylvania County is a relatively warm one. The summers are long and hot with an average mean temperature of 25.3° C. and the winters mild and short with an average mean of 4.2°C. The average frost free period extends from April 8 to October 24, a total of 199 days. The mean annual precipitation for Pittsylvania County is 101.6 cm (Fuller *et al.*, 1925).

Methods

In the summer and early fall of 1977, twenty-two stands were sampled which (1) were upland, (2) were predominantly hardwood, (3) showed no or little obvious signs of recent disturbance, (4) appeared to be uniform in composition, and (5) were at least 5 acres (2.02 ha) in area.

In each stand, dominance was determined by measuring basal area (cross-sectional area, breast high, in m^2/ha) by the Bitterlich method, using a Spiegel Relaskop (angle gauge). Density for each species (in

trees/ha) was determined by counts of stems (>10.16 cm dbh) found within a circular plot of 10 meters radius. Relative dominance and relative density were calculated for each species, and an average of the two values was taken as the relative importance value (I.V.). Diversity of each stand was calculated using the Shannon-Weiner formula. Because of the difficulty in distinguishing between *Carya glabra* and *C. ovalis* during the summer months when mature fruit were not available, the practical policy employed by many foresters of lumping the two taxa as *C. glabra* was followed. Otherwise, taxonomic nomenclature follows Radford, Ahles, and Bell (1968).

An ordination of the 22 stands was established by using techniques based on those of Bray-Curtis as employed by Gemborys (1974) in his study of Virginia Piedmont forests. Because the third (Z) axis was highly negatively correlated ($=-.91$) to the X axis, it provided no significant new information, and the ordination of the 22 stands presented here was established using only the X and Y axes. A tabular summary of structural characteristics and species importance values for all 22 stands are available upon request.

At each point sampled within a stand, the percent slope (using the Spiegel Relaskop) and direction of slope were recorded, and then these were averaged for the entire stand. Several (3 or 4) soil samples from the top 15 cm were collected at irregular intervals throughout each stand and were mixed well. A portion of each was forwarded to the Agricultural Cooperation Extension Service at VPI and SU in Blacksburg, Va., where the values for pH, Ca, Mg, P, K, and N were determined. The remaining soil was analyzed for sand, silt, and clay percentage in each stand using differential settling from aqueous suspension as employed by Bowers (1976). The process was performed twice for each soil sample and the two values averaged.

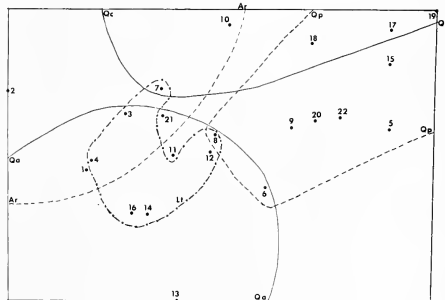
FIG. 2—Areas of concentration on the ordination of five major upland hardwood forest species. Upper right broken line (Qp) encloses stands with *Quercus prinus* I.V. > 20; lower left solid line (Qa), *Q. alba* I.V. > 16; upper solid line (Qc), *Q. coccinea* I.V. > 13; central dot-dash line (Lt), *Liriodendron tulipifera* I.V. > 10; upper left dotted line (Ar), *Acer rubrum* I.V. > 9.

Table I. Average importance values (IV), number of times each species was ranked as one of the top five species, number of stands where species was found, and highest IV obtained for the species.

Species	Number of times ranked					Average IV	Presence (out of 22)	Highest IV obtained
	1	2	3	4	5			
Quercus alba	10	4	5	3	0	20.8	22	50.9
Quercus prinus	7	2	1	2	0	21.1	16	74.9
Acer rubrum	2	2	1	2	3	6.9	19	23.1
Quercus coccinea	1	4	9	0	2	11.0	21	37.0
Carya tomentosa	1	0	0	1	1	3.3	15	19.0
Quercus falcata	1	0	1	0	0	2.6	13	23.4
Liriodendron tulipifera		4	2	0	2	6.7	13	23.6
Nyssa sylvatica		1	1	4	4	5.3	21	15.7
Carya glabra		1	0	1	3	3.3	15	12.3
Pinus echinata		1	0	1	1	3.0	14	13.8
Oxydendrum arboreum			4	2	2	4.8	18	12.1
Pinus virginiana			1	0	1	1.9	13	12.9
Liquidambar styraciflua				1	0	.9	3	12.1

Results

A total of 22 species were recorded in sample plots. *Querus alba* and *Quercus prinus* were the two most important species, ranking first in I.V. in 10 and 7 of the 22 stands. Five other species were leading dominants in at least one stand (Table I).

Quercus alba was concentrated in the lower left-hand corner of the ordination (Fig. 2). It ranked among the top four species in I.V. in each of the 22 stands sampled, and was the most important species in 45% of them. In contrast, *Quercus prinus* was structurally more important in the stands of the upper right-hand portion of the ordination. Although it had the highest average importance value for the 22 stands, it occurred in only 73% of the stands and became one of the five leading dominants in only 55% of the stands. In several of the stands with a high importance value of *Q.*

prinus, many *Q. prinus* individuals were stump sprouts, very often with three to four large trunks growing from a single base. This may have produced inflated importance values in many of those stands heavily dominated by *Q. prinus* (since stems were counted at breast height). No other species was noted exhibiting multiple stump sprouts nearly as often. *Quercus prinus* reached its highest importance value of 74.9% in stand 5.

Quercus coccinea was concentrated in the upper section of the ordination. It occurred in 95% of the stands, becoming one of the five most important species in 73%. Much of its area of concentration on the ordination overlapped with that of *Q. prinus.*

Acer rubrum was concentrated in the upper left-hand corner of the graph. It occurred in most (86%) of the stands but was one of the five most important species in only 45% of them. *Acer rubrum* had the

fourth highest average importance value even though it generally occurred as an understory tree. Large, tall maples were encountered in the overstory, however, especially in ravines and draws.

Liriodendron tulipifera, Quercus velutina, Nyssa sylvatica, and *Oxydendrum arboreum* also were structurally important in the upland hardwoods of the county. The area of concentration for *Liriodendron* lies almost entirely within that of *Quercus alba* (Fig. 2). *Quercus velutina,* absent from only two stands, was concentrated in a lower left area bounded by and including stands 4, 21, 6 and 13. *Nyssa sylvatica* was very widespread, occurring in all but one stand, but the only stands where it reached an I.V. >9 were stands 4, 3, 21, and 8. *Oxydendron arboreum,* also widespread, nevertheless achieved its greatest importance at higher y values: stands 3, 11, 20, 15 and those above have I.V. = 5.6-12.1; stands 2, 4, 8, 9, 22 and those below have I.V. = 0-5.4. *Quercus falcata,* though a leading dominant in one stand, achieved significantly high importance values for only two stands (stands 1 and 2), which lie in the far left side of the ordination.

The range of diversity extended from as low as .403 (stand 5) to 1.019 (stand 21). In general, stands that are more to the right had lower diversity than stands on the rest of the graph, though the most diverse stands centered in the mid-left section of the graph. Diversity was highly negatively correlated (p = + .001) to the x-axis, confirming the pattern detectable by inspection.

Soil analysis revealed generally low mineral availability and a narrow range for pH (4.3-5.3). In all except stand 7, the amount of nitrogen was negligible ($<$ 5 lb/acre). The stands in the upper right portion of the ordination (stands 19, 17, 15, 18, 5, and 6, and to a lesser degree stands 22, 20, and 9) had generally lower values for Ca, Mg, K, and P, as well as pH, when compared with other stands. These were the nine stands which also had the highest *Quercus prinus* I.V. Indeed, each of the 4 minerals had negative correlation coefficients with both the x and y axes, although the only statistically significant correlations were the negative correlations with the x axis of Mg (P = + .05) and pH (p = + .01)

Average slope for each stand formed no specific pattern on the ordination though those stands on the right side of the graph, where x $>$ 50, were slightly less sloping than those on the left. All those stands with x greater than 50 had a slope of less than 10%, whereas stands (except 11 and 1) on the left side of the graph had a slope greater than 10%.

Discussion

Two major types of stands were encountered in the upland hardwood forests of Pittsylvania County, with a few stands having intermediate characteristics. One type of forest, hereafter called chestnut oak forest, contained *Quercus prinus* as the major species and had a relatively low diversity. These stands all had an x $>$ 55 (stand 9 and rightward, Fig. 2). *Quercus coccinea* and *Q. alba* were generally next to *Q. prinus* in impor-

tance, and *Oxydendrum arboreum* was the most common understory tree. In the forests of this type, no species other than the four mentioned above and the two successional pines *(Pinus echinata* and *P. virginiana)* obtained an importance value greater than 9.0.

The second type of forest included stands in which *Quercus alba* was important, usually as the leading dominant, and these stands had relatively high diversity. *Quercus prinus* was relatively unimportant, while *Acer rubrum* or *Liriodendron tulipifera* often ranked high in importance. All stands had an x value $<$ 35 (stand 11 and leftward, Fig. 2). Two stands with x $<$ 35 (stands 2 and 7) did not have *Q. alba* as the leading dominant; in these it ranked third and fourth respectively. However, these two stands had high diversity, had *Acer rubrum* ranked as one of the leading species above *Q. alba,* and had no *Q. prinus.* These stands, therefore, are considered in this second category, referred to as the white oak type of forest.

Five stands (6, 8, 10, 12, and 13) fell between the white oak and chestnut oak types. Diversity values lay between those of the other two groups, and stand composition often had similarities to both groups, with still another oak species, *Quercus velutina,* obtaining its two highest I.V.'s here.

In general, chestnut oak forests had gentler slopes, lower soil mineral availability, lower pH, coarser textured soils, and occurred more frequently in the western section of Pittsylvania Co., although there were two stands of this type well within the eastern part of the county. In stands of the white oak type, degree of slope, soil mineral availability, pH, and soil texture were more variable but were generally steeper, higher, and finer, respectively.

When all stands are considered together, the results place the forests of Pittsylvania Co. well within the oak-hickory climax described by Oosting (1956) and Kuchler (1964). All of the top seventeen species in importance in Pittsylvania Co. were among Kuchler's (1964) list of dominants and components of his oakhickory-(pine) region.

The forest of the southern Piedmont of Virginia show similarities to the paradigmatic oak-hickory climax forests studied in the Piedmont of North Carolina by Oosting (1942). In both studies, two forests types were encountered, and one is characterized by high importance of *Quercus alba,* while the other type occurs in poorer soils. In our area, however, *Quercus prinus,* not *Quercus stellata,* is the dominant in this second forest type. Like Oosting (1942), we found *Quercus rubra* (his *Q. borealis*) to be unimportant, and *Quercus coccinea* to be among the several more important species. Our study sites have even greater similarities to these of Gemborys (1974) in Prince Edward Co. Prince Edward lies about 45 miles further east than Pittsylvania, and its southernmost border is about even with Pittsylvania's northernmost border. For the 24 upland forest stands (x $>$ 45) he sampled in Prince Edward Co., Gemborys (1974) reported the eight most important species to be *Quercus alba, Q. rubra, Acer rubrum, Q. prinus, Nyssa sylvatica, Q. falcata, Carya*

tomentosa, and *Liriodendron tulipifera.* Except for *Quercus rubra,* all these occurred in over two-thirds of the stand sampled in Pittsylvania Co., and each was one of the two leading dominants in at least one stand. Of the twelve top species of Pittsylvania, all but two, *Q. coccinea* and *Q. velutina,* occurred in over 40% of the upland stands of Prince Edward Co. However, these three exceptions, *Q. rubra, Q. coccinea,* and *Q. velutina,* are very significant ones.

Quercus coccinea, occurring in 95% of the stands and holding the third most important position overall in the upland forests of Pittsylvania Co., was not reported once in either the tree layer or the sapling-shrub layer of any of the stands sampled in Prince Edward Co. by Gemborys (1974). *Quercus velutina,* occurring in 86% of the stands (and ranking among the top 4 species in 31%) in Pittsylvania Co., occurred in only 33% of the upland stands in Prince Edward Co., and did not rank among the top four species of a single stand. *Quercus rubra,* reported by Gemborys (1974) as his second most important species, occurring in 95% of the upland stands, was sampled in the tree layer of only one of the 22 stands sampled in Pittsylvania Co. Considering the short distance between the two counties,

additional study is needed to explain such differences between the two with respect to these three species.

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Book Review

The Marine Algae of Virginia. By Harold J. Humm. Illustrated. The University Press of Virginia, Charlottesville, Virginia. 1979. 263 pp. $12.50.

Prior to the publication of this book there had been no comprehensive, convenient source of information to aid in the identification of marine algae growing along any region of the mid-Atlantic states. The author is well qualified to treat this subject and has produced a valuable and generally very usuable guide to the microscopic and macroscopic benthic algae of Virginia. A relatively sparse marine flora is found along the numerous tidal rivers, bays and marshes, the Chesapeake Bay and the limited oceanic coastline (176 species are treated in this book; the author believes that over 200 will eventually be recorded), and many of these are restricted to periods of either warm or cold water temperatures. In spite of the small total number of species found during any season, the total number of individuals is often considerable and the other available keys from more northerly or southerly areas have often proven to be reliable only to genus designation at best.

The introduction includes a brief synopsis of the history of marine algal activities in Virginia, a discussion of the environmental features affecting local algal growth, occurrence and distribution, and general comments on the specific nature and relationships of Virginia algae in comparison to neighboring floras. A systematic list of species is presented and the major characteristics of each major group (Cyanophyta, Rhodophyta, Xanthophyta, Phaeophyta and Chlorophyta) is concisely discussed. Keys to the genera or species follows the introductory remarks of each division and there is an account of each class or subclass, order, family, genus and species. There are illustrations of a little over half of the described species, these being either photographs of herbarium specimens or drawings of entire or selected portions of plants. A short glossary is included as well as an adequate bibliography and index.

The major shortcoming of the book relates to the illustrations. Algae are widely recognized for their extreme morphological plasticity. Photomicrographs or detailed drawings of critical vegetative and reproductive structures have always proven to be more reliable for macroscopic algae than photographs of herbarium specimens, especially when most of the latter are not accompanied by a scale, an inconsistency readily noticeable in this book. Also, some of the photographs are not especially clear (Fig. 39 of *Antithamnion cruciatum,* for example) or do not demonstrate the essential features used to distinguish between closely related species (Fig. 102, *Bryopsis plumosa* and Fig. 103, *B. hypnoides*), and a seemingly disproportionate photographic coverage is given to three brown algae which are not residents of Virginia and occur only in the drift (3 full plates of *Sargassum* species). Careful attention to the quality and appropriate types of illustrations is a difficult and time consuming job, but is immeasurably useful in algal keys, especially for students first introduced to seaweeds who more often than not include several herbarium specimens of hydroids in their general collection of "seaweeds".

The other noticeable deficiencies are found in the introductory remarks to some of the different algal groups. The statement that the Rhodophyta possess chlorophyll c is an unfortunate error and the well-known evidence of pit connections in the microscopic stages of some members of the Bangiophyceae no longer supports the author's contention that "there are no cytoplasmic connections between cells" in this red algal group. Also, some mention should have been made of the newly proposed systems of classification of the green algae which clearly indicate that more than gross morphological and life history considerations are necessary in modern taxonomic appraisals.

Overall the book is well organized, easy to use and is most definitely a welcome addition to the meager literature on the marine algae of the east coast of the United States. Harold Humm should be applauded for his efforts.

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NOTES

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All manuscripts and correspondence about them should be addressed to the **Editor**. The Virginia Journal of Science welcomes for consideration original articles and short notes in the various disciplines of engineering and science. Cross-discriplinary papers dealing with advancements in science and technology and the impact of these on man and society are particularly welcome. Submission of an article implies that the article has not been published elsewhere while under consideration by the Journal.

The original and two copies of each manuscript and of all figures therein are required. *Authors should submit names of three potential reviewers.* All articles should be typewritten, double-spaced throughout, on one side of good bond paper ($8\frac{1}{2} \times 11$ inches). Margins should be not less than $1\frac{1}{4}$ inches on any border. Each manuscript should be complete and final when submitted. It should include the title, author's name and affiliation, and proposed running title, all appear-

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> Fujishima, A., and Honda, K. 1972. Electrochemical Photolysis of Water at a Semiconductor Electrode. Nature 238: 37-38.
>
> Spry, A. 1969. Metamorphic Textures. Pergamon Press, New York. 350 pp.
>
> Guliday, John E. 1971. Pleistocene History of the Appalachian Mammal Fauna. *In* Distributional History of the Southern Appalachians, Part III. Vertebrates (Perry C. Holt, ed.), pp. 223-262. VPI & SU, Blacksburg, Va.

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For illustrations, glossy prints are preferred to drawings. Each figure and table should be mentioned specifically in the text, with all figure numbers and legends typed consecutively on separate sheet, and the figures identified by author's name and figure number in pencil on the back. Table numbers and legends should be included as part of the table.

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Modeling of a Solar-Pumped Iodine Laser

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Abstract—The direct conversion in space of solar radiation into laser radiation for power transmission to Earth, satellites, or deep space probes shows promise as a reasonably simple technology and may have cost advantage in deployment and greater reliability compared to other methods of space power generation and transmission. The main candidates for solar pumping are the gas dynamic, photochemical, and direct photoexcited lasers. We consider here the photochemical reaction of alkyliodides which predominantly excite the $I(^2P_{1/2})$ state which then lasses at 1.315 um. The iodine ground state is eventually lost to reconstituting the gas or in the formation of molecular iodine. The rates at which the gas is required to be recycled through the laser system are modest. The side exposure at 100-fold solar concentration of a 100-m long tube with a 1-m^2 cross section is estimated to provide 20 kW of continuous laser output. Scaling laws and optimum operating conditions of this system are discussed.

Introduction

The potential use of lasers for space power transmission is well recognized (Coneybear, 1978). Of the several options for the generation of laser beams in space, the direct conversion of solar radiant energy into a population inversion appears particularly attractive (Rather, 1978). The direct conversion in space of solar radiation into laser energy holds promise as a reasonably simple technology and may have cost advantages in deployment and greater reliability compared to other methods of space power generation. We develop herein a preliminary kinetic model for a solar-pumped atomic iodine laser. Some attention is given to the chemical reversibility and reprocessing requirements. A preliminary design of a small demonstration solar-power satellite for use in space is considered.

Kinetic Model

An energy level diagram for the photolytic-pumped alkyliodide gas with the major kinetic pathways is shown in Figure 1. The alkyliodide starting gas is represented by the symbol RI where R denotes the alkyl radical. Through photoabsorption denoted by the ascending zig-zag path, an excited RI* molecule is formed which dissociates in a free alkyl radical plus a metastable iodine atom I*. The free alkyl radicals combine only slowly to form stable alkyl dimers R_2. Alkyl recombinations with atomic iodine is fast once the iodine has reached its ground state. The free iodine
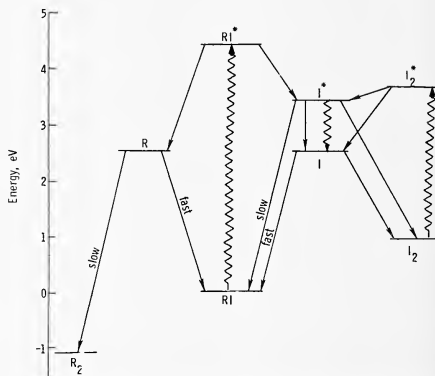
Fig. 1—Energy level diagram of the alkyliodide photochemical laser showing kinetic pathways.

combines slowly to form iodine molecules which are subsequently photodissociated. The formation of alkyl dimers causes loss of material in the system which requires chemical reprocessing. Chemical reprocessing requirements are discussed subsequently. The corresponding rate coefficients are shown in Table 1. The photodissociations denoted as the ascending zig-zag lines have their rates calculated according to a thermal source at temperature T. The air mass zero (AMO) solar UV emission corresponds to that of a blackbody with a temperature of 5400°K, although the visible and IR emission corresponds to temperatures of 5762°K. The unit solar concentration thus contains 1 percent of the insulation (1.4 kW m⁻²) in the UV band from 250 to 300 nm. The photodissociation rates are found from the absorption line parameters in Table II. The photoemission denoted by the descending zig-zag line from the I* has an Einstein A coefficient of 7.7 sec⁻¹ (Beverly and Wong, 1977). The kinetic equations are taken from Beverly and Wong (1977) with source terms appropriate for solar pumping and disregarding the I* + I* recombination included in their model. The

Table I: Chemical Reaction Rate Coefficients*

	Beverly-Wong	Hohla-Kompa	Fisk	Value Used	Symbol
$I^* + R \rightarrow RI$	2.7 E - 12	-----	1.5 E - 12	1.5 E - 12	K_1
$I^* + I_2 \rightarrow I + I_2$	(3.6±0.3)E - 11	3.5 E - 11	3.6 E - 11	3.6 E - 11	Q_2
$I^* + RI \rightarrow I + RI$	2.8 E - 16	8.0 E - 16	------	8.0 E - 16	Q_1
$I + R \rightarrow RI$	(1.5±0.5)E - 10	-----	5.0 E - 11	5.0 E - 11	K_2
$R + R \rightarrow R_2$	4.2 E - 12	1.0 E - 11	1.5 E - 13	1.5 E - 13	K_3
$I + I + I_2 \rightarrow 2I_2$	7.4 E - 32	2.9 E - 30	------	2.9 E - 30	C_4
$I^* + I + I_2 \rightarrow 2I_2$	1.5 E - 31	4.3 E - 32	------	4.3 E - 32	C_3
$I + I + RI \rightarrow I_2 + RI$	7.8 E - 33	4.5 E - 31	------	4.5 E - 31	C_2
$I^* + I + RI \rightarrow I_2 + RI$	1.6 E - 32	1.6 E - 33	------	1.6 E - 33	C_1

*Units for two-body coefficients are cm^3/s while three-body coefficients are cm^6/s

Table II: Photodissociation Parameters (Hohla and Kompa, 1976)

	σ_0, cm^2	λ_0, μm	D_0, μm
C_3F_7I	5.4 E - 19	0.275	0.014
I_2	17.0 E - 19	0.500	0.027

σ_0 - peak cross section

λ_0 - central wavelength

D_0 - rms bandwidth

$I^* + I^*$ recombination is inhibited due to the strongly repulsive $I^* + I^*$ potential. Hence

$$\frac{d[R1]}{dt} = K_1[R][I^*] + K_2[R][I] - S_1[R1]$$

$$\frac{d[R]}{dt} = S_1[R1] - K_1[R][I^*] - K_2[R][I] - 2K_3[R][R]$$

$$\frac{d[R_2]}{dt} = K_3[R][R]$$

$$\frac{d[I_2]}{dt} = C_1[I][I^*][R1] + C_2[I][I][R1] + C_3[I][I^*][I_2] + C_4[I][I][I_2]$$
$$- S_2[I_2]$$

$$\frac{d[I^*]}{dt} = S_1[R1] + S_2[I_2] - K_1[R][I^*] - C_1[I][I^*][R1] - C_3[I][I^*][I_2]$$
$$- Q_1[I^*][R1] - Q_2[I^*][I_2] - \overline{\Gamma}_{23} - A[I^*]$$

$$\frac{d[I]}{dt} = S_2[I_2] + Q_1[I^*][R1] + Q_2[I^*][I_2] + \overline{\Gamma}_{23} + A[I^*]$$
$$- C_1[I][I^*][R1] - 2C_2[I][I][R1] - C_3[I][I^*][I_2]$$
$$- 2C_4[I][I][I_2] - K_2[R][I]$$

$$\frac{d\rho}{dt} = h\nu\,\overline{\Gamma}_{23} - \rho/\tau_c + h\nu A g[I^*]$$

$$\overline{\Gamma}_{23} = \omega_{23}\left([I^*] - \frac{[I]}{2}\right)$$

$$\omega_{23} = \lambda^2 A\, c\rho/(4\pi^2 h\nu\,\Delta\nu)$$

$$\tau_c = -\left(\frac{L}{c}\right)\ell n\,(r_1 r_2)$$

$$g = 2r_b^2/L^2$$

where $\overline{\Gamma}_{23}$ is the stimulated emission rate, ω_{23} is the stimulation frequency, ρ is the intracavity photon energy density, τ_c is the lifetime of a photon in the resonator cavity, g is the geometric factor for the cavity, $\Delta\nu$ is the line width, L is the length of the laser cavity, r_1 and r_2 are end mirror reflection coefficients, and r_b is the laser beam width. The photodissociation rate coefficient of the isopropyliodide (i-C_3F_7I) for the AMO solar spectral irradiance using the absorption parameters of Table II is

$$S_1 = 2.44 \times 10^{-3}\ C\ sec^{-1}$$

where C is the solar concentration. Similarly, the iodine photodissociation rate coefficient is

$$S_2 = 4.2 \times 10^{-2}\ C\ sec^{-1}$$

These dissociation rates are calculated by integration of the photoabsorption cross section (parameters in Table II) over the solar spectrum. The power output

per unit area of the laser beam cross section is

$$P = c\rho t_m$$

where t_m is the transmission factor for the output mirrors.

The kinetic equations were integrated numerically up to the time at which the laser output became steady. This value of steady output was then calculated for differing values of solar concentration and filling gas pressure. Using He as a buffer gas at 70 Torr for a laser tube 100-m long with a 10-percent output coupling mirror, results are shown in Figure 2 where power output is expressed as power per unit area of output beam per unit solar concentration as a function of the alkyliodide mixing ratio. If the system efficiency was independent of solar concentration and alkyliodide pressure, then the curves in Figure 2 would all lie on a single straight line. It can be seen from the figure that system inefficiencies begin to enter at high solar concentrations or at high alkyliodide partial pressures. This implies that large laser volumes at low pressure are favored for space use.
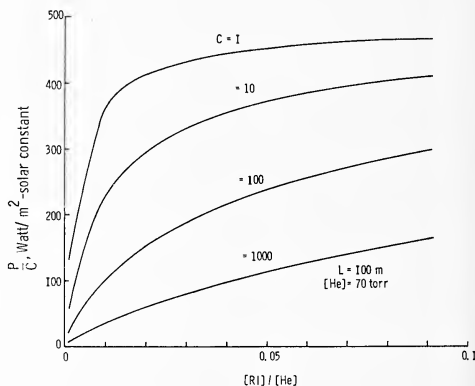
FIG. 2—Normalized solar-pumped laser output as a function of gas-mixing ratio for several solar concentration ratios.

When threshold is exceeded, the laser medium is saturated (i.e., the net gain is zero); the upper state and lower state population densities are related as

$$[I]_{sat} \approx 2[I^*]_{sat}$$

as seen from setting the stimulated emission rate $\overline{\Gamma}_{23}$ to zero. If we further assume that the alkyl-dimer is formed slowly as indicated in Figure 1, then

$$[R] \approx [I^*] + [I]$$

which follows from material conservation. Since a steady state the photodissociation source is nearly in

equilibrium with the alkyl-radical recombination rate, we have

$$S_1[RI] \approx K_1[R][I*] + K_2[R][I]$$

$$\approx 2/3K_2[R]^2$$

at saturation. The rate at which the alkyl-dimer is formed is given by

$$\frac{d[R_2]}{dt} = K_3[R]^2 \approx \frac{3}{2}\frac{K_3}{K_2}S_1[RI]$$

The fraction of dissociations which are lost to dimers is then

$$F_{loss} = \frac{3}{2}\frac{K_3}{K_2} \approx 4.5 \times 10^{-3}$$

for the isopropyliodide used here. Such dimers must be continuously removed from the gas and chemically processed to reform the lasant starting material. The removal of the dimers could be implemented with the circulation system for cooling the laser gas (Rather, 1978). It is clear from the above considerations that such recycling requirements for isopropyliodide should not be prohibitive for space operation since only a small fraction of the alkyl radicals are lost to dimer formation.

Chemical reprocessing requirements can be further reduced by choosing alkyl radicals for which the rate of dimer formation is slower (i.e., smaller K_3). Figure 3 shows F_{loss} as a function of the dimmer formation rate coefficient where data for various free radicals taken from Fisk (1977) are shown. The advantage of the T-butyliodide over the isopropyliodide is clearly evident from the figure. The isomeric structure will be of further importance insofar as dissociation of the dimer in that the (t-butyl) - (t-butyl) will have a different resonance energy than a normal carbon-carbon bond which may be utilized in reforming the starting lasant material.

Satellite Power Station

We choose for a solar collector a parabolic cylindrical reflector with the laser tube at its focal line. A back reflecting right circular cylinder causes double traversal of the laser tube as shown in Figure 4. The parabola extends to only that part subtended by the latus rectum, ensuring all rays to pass through the laser tube twice. The effective solar concentration is given as

$$\frac{2f}{d} \leq C \leq \frac{16f}{\pi d}$$

where f is the focal length for the parabola and d is the mean diameter of the laser tube. The exact value of C depends on the alkyliodide pressure. Taking d as 1 m and f as 50 m generates a concentration C of 100 for which the power output according to Figure 2 is about 20 kW for alkyliodide concentrations of about 3 percent.
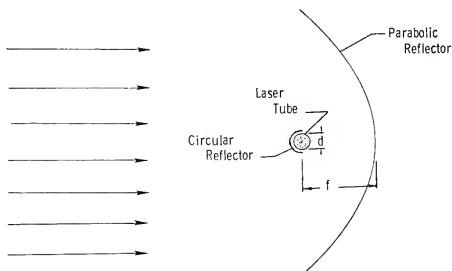
FIG. 4—Parabolic cylinder geometry for solar collector showing laser tube location.

FIG. 3—Lasant material loss rate for several alkyliodides.
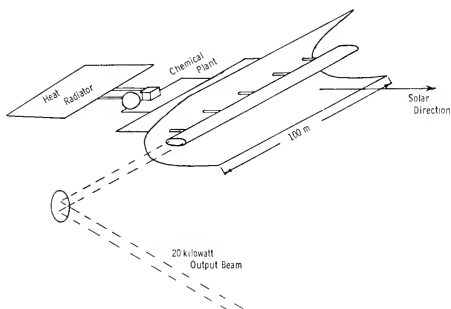
FIG. 5—A schematic view of a solar laser station with a 20-kilowatt output beam.

A possible configuration for a 20-kW solar-pumped laser facility is shown in Figure 5. The radiator size to reject the excess heat is about 100m². The chemical reprocessing is not yet defined although preliminary work has been done by Fisk (1977). While future research will undoubtedly reveal more attractive candidates for solar-pumped lasers, the present study demonstrates the potential of such power-generating facilities in space.

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Downstream Changes in Fish Species Composition After Construction of a Headwater Reservoir

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Abstract—Loss of cold water habitat resulting from reservoir con-
struction resulted in the elimination of *Salvelinus fontinalis* (brook
trout) and *Rhinichthys atratulus* (blacknose dace) from downstream
areas of John's Creek, Virginia and was probably responsible for the
absence of *Chrosomus oreas* and the reduction in numbers of *Cottus
bairdi* downstream from the reservoir. Shallowness of the reservoir
appeared to cause the higher downstream temperatures. The collec-
tive impact of improperly constructed impoundments in montane
areas could result in significant losses of cold water habitats and
associated species.

Introduction

Numerous small reservoirs have been built on the
headwaters of small, cold water streams in recent
years. The effects of these reservoirs on fish popula-
tions are generally assumed to be minor, but little
published information is available to substantiate this
assumption. In Virginia, there were 212 small reser-
voirs in 1977, and many more were being planned or
constructed (Soil Conservation Service data file).
Many of the existing reservoirs are located on cold
water trout streams. Although the downstream effects
of individual reservoirs on trout waters may not be
great, collectively these impoundments affect a large
percentage of the trout waters in the state. To evaluate
the effect on downstream areas, we documented the
effects on the fish species of one small headwater reser-
voir on John's Creek (Craig and Giles County, Vir-
ginia) where the fish population had been studied
before construction of the reservoir by Burton and
Odum (1945).

Study Site

John's Creek, a tributary of the James River, has a
watershed of about 23,306 hectares. The upper portion
(9.6 stream km) of the watershed consists of forested
mountains and the lower portion (32.2 stream km) of

sparsely populated agricultural and wooded land.
About 16 km below the origin, the creek enters an 11.3
hectare floodwater control reservoir constructed in
1965. The maximum depth of the reservoir is about 3.4
meters. The outflow facilities (multi level outlet) of this
reservoir were designed to release cold, hypolimnetic
water to protect the existing character of the stream.

Methods

Four sample stations were established; station 1 was
1.2 km upstream from the reservoir and the others
were downstream at various distances below the
reservoir—station 2 about 100 m, station 3 about 1.6
km and station 4 was 3.2 km. Fish populations were
sampled in the fall of 1976 by blocking 50 meter sec-
tions at each station with nets and conducting sam-
pling runs with a 230-V direct current electroshocker.
Population estimates were made by the procedure
recommended by Carle and Strub (1978). The removal
method of population estimation involved three sepa-
rate sampling runs, or removals, at each station. A
mathematical relationship between the three concur-
rent removals was used to estimate the total fish popu-
lation in each 50 meter segment. Species composition
and distribution were then compared with pre-im-
poundment information presented by Burton and
Odum (1945) for approximately the same sampling
locations (their stations 1, 3, 4, and 5). Quantitative
comparisons were not possible because Burton and
Odum did not collect population data. Burton and
Odum collected fish at each station by seining and dip
netting one to two hundred yard stream segments.

Temperatures were measured 2 to 3 times a month
from January to December 1976, at each station with a
hand-held thermometer.

Results

The estimated number of individual fish was lower at each station below the reservoir than at the station above the reservoir, but the number of species collected was about the same at all stations (Table 1). The number of species taken at each station was higher than that reported by Burton and Odum (1945). Ten species were found both above and below the reservoir, whereas 5 were taken only upstream and 10 species were taken only downstream (Table 2).

Temperatures were similar above and below the reservoir from 1 November 1975 to 15 March 1976, and from 2 November 1976 to 1 December 1976 (range 2-8° C). From 15 March 1976 to 4 October 1976, downstream temperatures always exceeded those from the upstream station (range upstream 10-16° C, range downstream 11-23° C).

Table 1. Estimated fish populations (number of individuals per 50 meter stream segment) in John's Creek, 22 September 1976 and 14 October 1976.**

| Species | Stations | | | |
	1 (1.2 km upstream)	2 (100 m downstream)	3 (1.6 km downstream)	4 (3.2 km downstream)
Catostomidae				
Catostomus commersoni	(2)	.		
Hypentelium nigricans			(1)	
Moxostoma rhothoecum	*25	*19	*14	(*1)
Centrarchidae				
Ambloplites rupestris				(2)
Lepomis auritus	9	(3)		(1)
Cottidae				
Cottus bairdi	*38	(*2)	(*2)	(*1)
Cyprinidae				
Compostoma anomalum	*14	*9	*16	*
Chrosomus oreas	34			
Clinastomus funduloides	*29	*23	*23	(*2)
Exoglossum maxillingua	(1)			4
Hybopsis micropogon	*5	*20	*	*
Notropis cornutus		16	12	*13
N. ardens		(1)	(1)	5
N. sp.		(1)		
Rhinichthys atratulus	*32	*	*	*
R. cataractae		6		
Semotilus atromaculatus			20	13
S. corporalis	43	30	7	*7
Esocidae				
Esox a. americanus		(2)		(1)
Ictaluridae				
Noturus insignis	2	21	10	1
Percidae				
Etheostoma flabellare	6	10	(2)	(1)
E. longimanum	*		(1)	*
E. nigrum	(1)			
Percina peltata				(1)
Salmonidae				
Salvelinus fontinalis	*7	*	*	*
Totals	248	163	109	51

* Found in this area by Burton and Odum (1945).
** When numbers captured were too low for a removal estimate (Carle & Strub 1978), actual catches (shown in parentheses) were used in place of estimates.

Discussion

Five species of fish were found only upstream from the reservoir (Table 2). In 1945, two of these species, *Salvelinus fontinalis* and *Rhinichthys atratulus*, occurred as far downstream as 4.0 km below station 4 but the other three species were not known to be present in

Table 2. Distribution of fishes in John's Creek after reservoir construction.

Location	Species
Upstream Only	Catostomus commersoni
	Chrosomus oreas
	Etheostoma nigrum
	** Rhinichthys atratulus
	** Salvelinus fontinalis
Downstream Only	*** Ambloplites rupestris
	Esox a. americanus
	Etheostoma longimanum
	*** Hypentelium nigricans
	Notropis ardens
	*** N. cornutus
	N. sp.
	Percina peltata
	Rhinichthys cataractae
	Semotilus atromaculatus
Upstream and Downstream	* Compostoma anomalum
	* Clinastomus funduloides
	* Cottus bairdi
	Etheostoma flabellare
	Exoglossum maxillingua
	* Hybopsis micropogon
	Lepomis auritus
	* Moxostoma rhothoecum
	Noturus insignis
	Semotilus corporalis

* Similar distribution reported by Burton and Odum (1945).
** Restricted distribution after reservoir construction.
*** Extended distribution after reservoir construction.

the system. Absence of certain species from Burton and Odum's (1945) study could have been due to inefficient sampling gear.

In contrast, 10 species were found only downstream from the reservoir (Table 2). Three of these species were reported to occur only a considerable distance below the present reservoir in 1945; *Notropis cornutus* then occurred upstream only as far as station 4 and *Hypentelium nigricans* and *Ambloplitis rupestris* penetrated upstream to a point several kilometers below station 4. Of the remaining seven species taken only downstream from the reservoir, six were not taken by Burton and Odum (1945) and the seventh, *Etheostoma longimanum*, was taken from sites both upstream and downstream from the reservoir location. We took only one specimen of *E. longimanum* (at station 3).

Burton and Odum (1945) collected one species, *Esox niger*, in the lower reaches of the stream (their stations 12, 13, 14, and 16) that did not occur in our samples. However, we collected *Esox americanus* at stations 2 and 4.

Ten species also occurred both above and below the reservoir (Table 2). Of these, eight seemed to be distributed equally upstream and downstream. *Noturus insignis*, one of the two remaining species, was scarce above the reservoir and the second, *Cottus bairdi*, was scarce below the reservoir. The original range of *C. bairdi* closely approximated that of *S. fontinalis* (Burton and Odum 1945).

Although a natural downstream transition in the fish community was observed by Burton and Odum

and us, that transition was not located in the same portion of the stream. In our study, the transition occurred abruptly at the reservoir. Burton and Odum did not see a similar change to warm water species until they were several kilometers below our station 4.

It is impossible to evaluate the effects of seasonal or annual differences on the distribution data; our data were taken in the fall and those of Burton and Odum were taken in the summer. However, except for *Salvelinus fontinalis,* these species are not known to show marked movements in summer and fall. Movements of *S. fontinalis* (brook trout) can occur in fall prior to spawning, when adult fish move to headwater areas (Scott and Crossman 1973). Movement of trout from John's Creek was not indicated, however, as *S. fontinalis* were found at Station 1. Therefore, it is probable that natural community changes were not responsible for the distribution we encountered.

Maximum summer temperatures at stations 2, 3, and 4 were between 21.0 and 23.0° C. Carlander (1969) reported upper lethal limits for *S. fontinalis* of between 21° and 26° C, depending on strain specific characteristics and 14°-19°C as preferred temperatures. High summer temperatures below the reservoir were probably responsible for elimination of the downstream trout population. Blacknose dace *(Rhinichthys atratulus)* are commonly associated with trout in cold water streams (Hubbs and Lagler 1958). It is likely that the high temperatures responsible for the elimination of trout from downstream areas of John's Creek also resulted in the loss of *R. atratulus* in those areas.

Higher downstream temperatures probably contributed to the absence of *Chrosomus oreas* and the scarcity of *C. bairdi,* even though maximum summer temperatures did not exceed lethal limits for these species.

Water temperature data collected at the same time as those collected for the present study showed that the shallow reservoir did not stratify during the summer, and that cold, limnetic water was not available for release downstream (Young 1977). The loss of trout habitat amounted to 7.2 stream km, which represents about 1/3 of the original amount present in John's Creek. Although this loss on one stream may not be important on a regional basis, the collective downstream impact of improper reservoir construction could be significant.

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Graph Theory I: The Mathematics of Structure

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Introduction

Chemical systems generally have structure; i.e. they contain elements (like atoms) which have interactions or connections (like bonds) between them. Whenever we can think of a structure as a set of elements connected by well-defined relations, there are many aspects of this structure which can readily be understood with what has come to be known as Graph Theory.[1-5] With this theory, structures can be classified according to their symmetries or general topology, and important reaction channels or paths through the structure can be identified. In this paper, some of the general aspects of graph theory are reviewed as well as its applications to chemistry. In another paper, a new flow graph, the Mass Balance Diagram, will be introduced as a tool in the study of reaction mechanisms. This diagram can be used to illustrate mechanisms (as linear combinations of elementary reactions), the stoichiometric number, and the distinction between a total mechanism and a Reaction Channel.

Graphs and Relations

Graph Theory is not concerned with the usual pressure-volume or temperature-time plots drawn to represent experimental or theoretical correlations. The graphs of Graph Theory are actually networks which indicate sets of elements together with the binary relations among pairs of these elements. Thus, a graph, $G = (\{x_i\}, R)$, is a finite set of elements, $\{x_i\}$, with a binary relation, R, defined on the set. An example of a graph would be:

$$G_1 = (\{C_1, C_2, C_3, C_4\}, \text{ is bonded to})$$

If the relation maps the elements in the following way, the graph might represent the carbon skeleton for n-butane:

C_1 is bonded to C_2,
C_2 is bonded to C_3,
C_3 is bonded to C_4.

The nature and specific properties of the relation will dictate the kind of graph it generates. Some examples are given in Table 1. Since the relation is central for the generation of a graph, it is useful to consider some definable properties of relations.

Table 1

Elements	Binary Relation	Kind of Graph
People	"is the parent of"	Family Tree
Cities	"is connected by rail to"	Railroad Map
People	"is in charge of"	Command Chart
Compounds	"combine to form"	Chemical Reaction
Atoms	"is bonded to"	Structural Formula

Symmetry

A relation R on a set $\{x_i\}$ is said to be symmetric if $x_i R x_j$ implies $x_j R x_i$. Any structural formula will illustrate a symmetric graph for, obviously, if atom A is bonded to atom B, then atom B is bonded to atom A.

If, however, only one of the following statement, $x_i R x_j$ or $x_j R x_i$, is allowed, then the relation (and the graph it generates) is said to be asymmetric or oriented.

For example, if our relation were "is older than", then either A is older than B or B is older than A. If every element in the set has the same age, then our relation is empty. (To avoid this kind of problem, the set of elements in the graph linked by the relation is usually defined to be a non-empty set.) Reversible reaction mechanisms will yield symmetric graphs while irreversible reactions will generate oriented graphs. Because so many reaction mechanisms are modeled with irreversible steps, the oriented graph can find much use in chemical kinetics; it also finds application in steady state situations, for example in the analyses of electrical circuits.[6]

Reflexivity

If for every x_i, x_iRx_i applies, then the relation is said to be reflexive. It is non-reflexive if x_iRx_i is not true for all of the members of the set.

Our previous example, "is older than", is non-reflexive. Examples of a reflexive relation are: "is iso-electronic with", and "is in equilibrium with".

Transitivity

If x_iRx_j and x_jRx_k, then x_iRx_k, we say that relation R is transitive.

An example of a transitive relation in chemistry is found in the Zeroth Law of Thermodynamics: If A is in thermal equilibrium with B and B is in thermal equilibrium with C, then A is in thermal equilibrium with C. More simply: if A and B have the same temperature and B and C have the same temperature, then A and C have the same temperature. Non-transitive relations are easy to find. As an example: if A is 10 kilocalories more stable (ΔG) then B and B is 10 kcal more stable than C, then it does *not* follow that A is 10 kcal more stable than C.

Equivalence

A relation which is symmetric, reflexive and transitive is said to be an equivalence relation.

Ordinary equality is perhaps our most familiar equivalence relation. The equivalence relations in some branches of mathematics important for chemistry are given in Table 2. Any equivalence relation allows us to separate the elements of a set into equivalence classes. While equivalence relations are important in structural chemistry and statistical thermody-

namics, it is the non-equivalence relations which are important in chemical kinetics since these generate oriented graphs. The essential feature of asymmetric, transitive relations (which are non-equivalent) is that they allow the elements to be ordered in a definite way, e.g. as reactants, intermediates and products.

Representations

So far, our graphs have been defined abstractly in terms of a set and a mapping relation on this set. But because the relation is binary, any graph can be represented as a network diagram where the *vertices* correspond to the elements of the set and the *edges* (lines between vertices) correspond to the binary relations. In Figures 1 and 2, network representations of a symmetric and an oriented graph are illustrated.

Again, because the relation is binary, i.e. links only pairs of elements, any graph can be represented by a square matrix. If in the mapping x_iRx_j, we let i label the columns and j label the rows, then a matrix representation can be written at once. In the examples in Figures 1 and 2, we have entered a 1 whenever the relation applies and a 0 whenever it does not apply between the ith and j^{th} elements of the set. Such matrices are called *associated matrices* but we prefer the term *matrix representations*. If the relation is non-
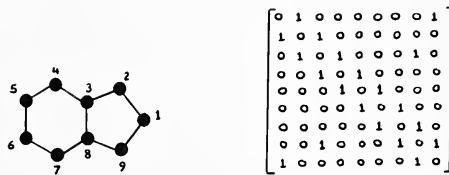
FIG. 1—Representations of a symmetric graph.

Table 2

Mathematics	Name
Arithmetic	Equality
Geometry	Similarity
Algebra	Isomorphism
Group Theory	Homomorphism
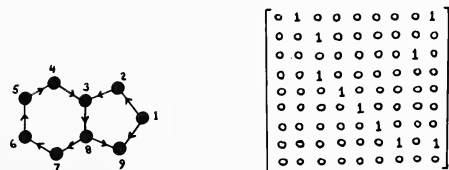
FIG. 2—Representations of an oriented graph.

reflexive, then only zeros will appear on the major diagonal ($x_i = x_j$) of the matrix. A symmetric relation will be represented by a matrix which is symmetric about its principal diagonal; i.e. the i-j^th *term will be equal to the j-i^th* term in the matrix. An oriented matrix will not be symmetric about its major diagonal. The matrix representation of a non-reflexive graph is often called an *adjacency matrix.* It is the adjacency matrix which figures so prominently in applications of graph theory to quantum chemistry.

There is much information in the adjacency representation which we can illustrate with reference to Table 3. In this table we have the network and adjacency matrix representation, [A], for three graphs which differ only in their mapping relation. Graph I is symmetric while Graphs II and III are oriented. If we sum the matrix elements in the ith *row* of an adjacency matrix, we obtain the number of accessible nearest neighbors (or outgoing one-step paths) adjacent to the ith element of the set. Element 2 has 3, 1 and 2 accessible nearest neighbors in Graphs I, II and III, respectively. If, on the other hand, we sum the matrix elements in the jth *column* of an adjacency matrix, we find the number of nearest neighbors for which the jth element of the set is accessible, or alternatively the number of one-step paths which end at the jth element. Element 2 is immediately accessible from 3, 2 and 1 nearest neighbors in Graphs I, II and III, respectively.

In a symmetric graph, the number of one-step paths to and from a given element will be equal. If the symmetric graph is a chemical structure, then this number will be the number of bonds to or the valence of the atom at the vertex in question; if the symmetric graph is a reaction scheme, this number will be the number of reversible reactions or equilibria in which a given species is involved.

Next we might ask, what elements can be reached in a two-step process and how many two-step processes do we have for any given element. These questions are answered by considering the square of the adjacency matrix, $[A]^2$. Thus, summing the matrix elements of the 2nd row of $[A]^2$ indicates that there are 5, 1 and 0 two-step paths from element 2 in Graphs I, II and III, respectively. Similarly, summing the 2nd column of $[A]^2$ indicates that there are 5, 1 and 0 two-step paths to element 2 in Graphs I, II and III, respectively. Of particular interest are those two-step paths which return us to the starting element, i.e. two-step cycles. For example, there are 3 two-step paths which begin and end on the second element in Graph I; in chemical structure, these would be single bonds. If multiple paths between adjacent elements are considered, e.g. multiple bonds, then it is easy to demonstrate that the diagonal matrix elements of $[A]^2$ correspond to the sum of the squares of the multiplicities. Thus, if an atom has a double and two single bonds, the sum of its row (or column) in the adjacency matrix would be 4 while its diagonal element in the corresponding $[A]^2$ matrix would be $6 = 2^2 + 1^2 + 1^2$.

These considerations can be generalized. The $[A]^n$ matrix could be used to study n-step processes and non-vanishing diagonal elements of $[A]^n$ would indicate n-step cycles which begin and end at the corresponding vertex of the graph. For the graphs in Table 3, we find no three-step cycles are possible, but four-step cycles occur in Graphs I and II; no cycles at all are possible for Graph III. In fact $[A]^n$ vanishes for Graph III for n greater than 2. For Graph II, we find that $[A]^5 = [A]$ so that there is a periodicity in the n-step linkages in that graph.

These properties of the adjacency matrix cannot be new, yet chemists do not seem to have employed them. We discovered them simply by playing with graphs.

Another matrix representation which has been employed in chemistry is the *incidence matrix* [B] which is a non-square matrix whose rows are labelled by the elements (vertices) and whose columns are labelled by the pairwise relations (edges) of the graph. An example of an oriented graph and its incidence matrix is given in Figure 3. The elements of the incidence matrix, B_{ij} are defined as follows:

$$B_{ij} = \begin{cases} 1 & \text{if vertex } i \text{ is the beginning of edge } j, \\ -1 & \text{if vertex } i \text{ is the end of edge } j, \\ 0 & \text{if vertex } i \text{ is not on edge } j. \end{cases}$$

The incidence matrix has ben used to generate lists of potential isomers of compounds for which only the chemical formula and mass spectrum are known.[7,8]

	Graph I	Graph II	Graph III
[A]	$\begin{bmatrix} 0&1&0&0&0 \\ 1&0&1&0&1 \\ 0&1&0&1&0 \\ 0&0&1&0&1 \\ 0&1&0&1&0 \end{bmatrix}$	$\begin{bmatrix} 0&1&0&0&0 \\ 0&0&0&0&1 \\ 0&1&0&0&0 \\ 0&0&1&0&0 \\ 0&0&0&1&0 \end{bmatrix}$	$\begin{bmatrix} 0&1&0&0&0 \\ 0&0&1&0&1 \\ 0&0&0&0&0 \\ 0&0&1&0&1 \\ 0&0&0&0&0 \end{bmatrix}$
$[A]^2$	$\begin{bmatrix} 1&0&1&0&1 \\ 0&3&0&2&0 \\ 1&0&2&0&2 \\ 0&2&0&2&0 \\ 1&0&2&0&2 \end{bmatrix}$	$\begin{bmatrix} 0&0&0&0&1 \\ 0&0&0&1&0 \\ 0&0&0&0&1 \\ 0&1&0&0&0 \\ 0&0&1&0&0 \end{bmatrix}$	$\begin{bmatrix} 0&0&1&0&1 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \end{bmatrix}$
$[A]^3$	$\begin{bmatrix} 0&3&0&2&0 \\ 3&0&5&0&5 \\ 0&5&0&4&0 \\ 2&0&4&0&4 \\ 0&5&0&4&0 \end{bmatrix}$	$\begin{bmatrix} 0&0&0&1&0 \\ 0&0&1&0&0 \\ 0&0&0&1&0 \\ 0&0&0&0&1 \\ 0&1&0&0&0 \end{bmatrix}$	$\begin{bmatrix} 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \end{bmatrix}$
$[A]^4$	$\begin{bmatrix} 3&0&5&0&5 \\ 0&13&0&10&0 \\ 5&0&9&0&9 \\ 0&10&0&8&0 \\ 5&0&9&0&9 \end{bmatrix}$	$\begin{bmatrix} 0&0&0&0&0 \\ 0&1&0&0&0 \\ 0&0&1&0&0 \\ 0&0&0&1&0 \\ 0&0&0&0&1 \end{bmatrix}$	$\begin{bmatrix} 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \\ 0&0&0&0&0 \end{bmatrix}$

TABLE 3: THREE GRAPHS DIFFERING ONLY IN THEIR BINARY RELATION WITH THEIR ADJACENCY MATRICES, [A], AND POWERS OF [A].

$$[B] = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & -1 & 0 & -1 \\ -1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & -1 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & 1 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \end{bmatrix}$$

FIG. 3—A graph and its incidence matrix.

Paths and Graphs

The first known paper on graph theory was published in 1736 by Euler in which he resolved the Konigsberg bridge problem.[9] This problem involves the discovery of a path having particular properties. The study of paths connecting the elements (vertices) of graphs is an important part of graph theory. It has guided the development of computer programing (flow charts), communications network analysis, critical path scheduling in operations research, and cryptography. Two important kinds of paths are the so-called Eulerian and Hamiltonian paths.

Eulerian Path:

   A path which is closed and which traverses every edge exactly once is called Eulerian.

Hamiltonian Path:

   A path which is closed but which traverses every vertex exactly once is called Hamiltonian.

To illustrate the distinction between these two kinds of path, suppose we are to conduct a tour of a campus which contains buildings of interest (vertices) and connecting walks and grounds (edges). If we plan a tour of the important buildings, and only wish to see them once, then we must find a Hamiltonian path on our campus map. If, however, we plan a tour of the grounds and do not wish to retrace any of the walks, we must find an Eulerian path through our campus.

The existence of a Hamiltonian path is related to the ergodic hypothesis of classical statistical mechanics. The necessary and sufficient conditions for the existence of a Hamiltonian path in a given graph is a major unsolved problem in graph theory. There is, however, a "soft" theorem due to G. A. Dirac:[4] If a graphs is simple, i.e. if every pair of its vertices is connected by only one edge, if there are n vertices, and if each vertex

is the end-point of n/2 paths, then a Hamiltonian path can be found. The theorem gives a sufficient but not a necessary criterion for the existence of an ergodic or Hamiltonian path. Figure 4 illustrates a Hamiltonian graph which satisfies Dirac's criterion.
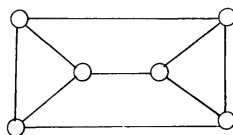
FIG. 4—A Hamiltonian Graph which satisfies Dirac's criterion.

The Euler path is illustrated in Figure 5 with the children's problem of drawing a house with one continuous line without retracing a line. Euler proved that if every vertex is the end-point of an even number of edges or if only two vertices are end-points of an odd number of edges, then an Eulerian path exists.[1]
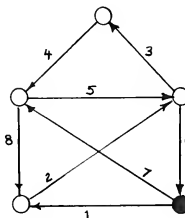
FIG. 5—An Eulerian Graph.

By assigning weights to the edges of a graph, one can order different paths according to preconceived priorities. This is the basis for critical path analysis which has been reviewed elsewhere.[2] The applications of graph theory to path analyses can involve rather more sophisticated mathematics than matrix algebra.

A Survey of Applications

The first applications of graphs in chemistry were probably the structural formulas introduced by Couper, Crum Brown, Frankland and Kekulé in their development of early valence theory. Today, they are the basis for characterizing both organic and inorganic compounds.[10-12] With the increasing use of computer search techniques, a number of nomenclature systems have been introduced which are based upon graph theory.[7, 13-15]

The determination of possible isomers was another early application of graph theory. This topic has been reviewed in depth by R. C. Read and A. T. Balaban.[1]

Perhaps the most widely pursued application of graph theory to chemistry is found in quantum chemistry.[16] In the zero-overlap approximation, the adjacency matrix (representing bonding interactions) commutes with the Hamiltonian in Huckel Theory. This fact has been used to good effect in determining the pi-electron energy spectrum of homo- and heterocyclic compounds. A number of very good reviews of these applications are available.[1, 5, 17] In considering these reviews it is interesting to note how much of the success of the Huckel Molecular Orbital approach is due to the validity of the graphical structural formula and how little is due to the detailed quantum assumptions.

The use of graphs in statistical thermodynamics is perhaps best represented in the cluster expansions of Mayer[18] and in the polymer studies of Gordon.[1]

Although graph theory has found many significant applications in path analysis, its application to reaction networks has not been well developed. Happy exceptions are the stability analyses of Clarke[19] and the study of the possible stereoisomers of pentacoordinate complexes via a Berry process.[20, 21]

Concluding Remarks

The authors have found graph theory to be both fun and interesting, but they have also found it to be important for chemistry. We hope that this brief review will transmit some of our new-found enthusiasm and that others will be stimulated to read about this field of applied mathematics. We are convinced that graph theory should be given equal time with group theory (which can be considered a subdiscipline) in chemistry curricula.

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Kepone Uptake by Algae and Effects on Growth Photosynthesis and Respiration

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Abstract—The insecticide Kepone inhibited growth, photosynthesis, and respiration of *Chlorella sorokiniana* and *Chlorococcum hypnosporum*. The insecticide reduced rates of respiration more than photosynthesis. Uptake of ^{14}C-Kepone by the algae was proportional to cellular concentration. A net efflux of Kepone was exhibited by *Chlorella* cells after 30 minutes of incubation, whereas, equilibrium occurred within 15 minutes of incubation for *Chlorococcum*. Desorption of Kepone was evident when both algal species were removed from Kepone treated solutions and incubated in untreated nutrient solutions.

Introduction

Contamination of the James River in Virginia by the insecticide Kepone (decachlorooctahydro-1,3,4-metheno-2H-cyclobuta cd pentalen-2-one) poses a threat to aquatic and terrestrial biota as indicated by the toxicity, bioconcentration and bioaccumulation of Kepone in estuarine organisms (Hansen et al., 1976 and Hansen et al., 1977). Its presence in water has become increasingly important as a determining factor on the quality of the environment. Removal of Kepone from the environment may occur slowly by degradation. The role that aquatic organisms play in removal of Kepone is not clear. The accumulation of pesticides by aquatic organisms may alter the organisms' metabolism, result in biodegradation of the pesticide, cause death of the organisms, or a combination of these. Reports have indicated resistance of some organisms (i.e. algae) to particular pesticides and survival of these organisms even though they accumulate pesticides to levels much higher than those in the external environment (Menzel, 1970; Vance and Drummond, 1969; Wurster, 1968). Accumulated and persistent pesticides are distributed to areas away from the source of the pollutant by mobile organisms and flowing water.

Algae are common aquatic organisms and they alter water quality by modifying pH, color, turbidity and concentration of inorganic and organic compounds. In recent years, algae were shown to accumulate and produce toxic substances which affect wild and domestic animals (Palmer, 1962). Algae are somewhat resistant to certain organic compounds such as herbicides (Valentine and Bingham, 1976) and chlorinated insecticides and, as a result of accumulation, can cause severe effects on organisms higher in the food chain (Vance and Drummond, 1969; Bahner et. al., 1977).

The objectives of this research were to evaluate uptake and accumulation of Kepone by two species of green algae, and to determine the effects of the insecticide on algal growth, photosynthesis, and respiration.

Materials and Methods

Algal culture. Chlorella sorokiniana Shihira and Kraus and *Chlorococcum hypnosporum* Starr were grown under aseptic conditions in 0.5 strength Bold's basic medium (James, 1974), pH 7.0, at room temperature with a light intensity of 90 $\mu E \cdot m^{-2} \cdot sec^{-1}$ provided by fluorescent lamps and aerated with filtered, humidified, compressed air. Light intensity was measured with a Lamda Model LI-170 quantum meter.

Effect of Kepone on algal growth. After 4 days of growth, the cells were harvested by centrifugation, 300 × g for 2 min, resuspended in sterile nutrient solution, pH 8.0, and counted with an improved Neubauer counting chamber. The cells were transferred to 125 ml Erlenmeyer flasks, 50 ml per flask, and treated with 0.5, 1.0, 1.5, and 2.0 ppm (w/v) of Kepone. Four replications of each treatment were prepared. Stock solutions of Kepone were prepared in acetone and the same amount of acetone, 2.5 μl, was also added to the controls. The flasks containing the algae were placed on a rotary shaker set at 80 excursions·min⁻¹ under fluorescent lamps with 85 uE·sec⁻¹ at the surface of the treated culture solutions. The algae were incubated under aseptic conditions at 25°C and aerated with 200 cm³·min⁻¹ of filtered, humidified, compressed air. Initial cell concentrations were 1 × 10⁵ *Chlorella* cells·ml⁻¹ and 4 × 10⁴ *Chlorococcum* cells·ml⁻¹.

Effect of Kepone on photosynthesis and respiration. Algal cells were harvested from the growth experiment after 96 hr of incubation with Kepone, resuspended in sterile nutrient solution, and the photosynthetic and respiratory rates were determined by measuring changes in oxygen concentration in solution with a Gilson Medical Electronics Oxygraph, Model K-1CC, equipped with a Clark electrode and a 2 ml glass reaction chamber. The reaction chamber was enclosed in a glass water jacket maintained at 25°C with a constant temperature circulating water bath. The reaction chamber was illuminated with one 300 W, 120 V, Ken-Rad reflector lamp placed on each side of the reaction cell. Each lamp provided 2000 µE·m⁻²·sec⁻¹ at the surface of the reaction vessel. Tap water flowing through a Pyrex container between each lamp and the reaction chamber served as a heat filter. Respiration was measured in the dark and photosynthetic rates are corrected for dark respiration. Cell concentration for *Chlorococcum* was 6 × 10⁶ cells·ml⁻¹ in both photosynthesis and respiration experiments; for *Chlorella,* it

was 1×10^7 cells•ml⁻¹ in the photosynthesis experiments, and 1×10^8 cells•ml⁻¹ in the respiration experiments. Chlorophyll content was measured by the method of Arnon (1949). The data were tabulated as averages of 5 replications.

Removal of Kepone from solution by algae. Algal cells grew in nutrient medium for 4 days, were harvested by centrifugation, resuspended in sterile nutrient medium, transferred to a 6 liter Erlenmeyer flask, 3 liters per flask, and aerated with 500 cm³•min⁻¹ of filtered, humidified, compressed air. After 10 days in a growth chamber at 25° and 85 μE•sec⁻¹, the algae were harvested, and each of the following cell concentrations, 1×10^6, 5×10^6, and 1×10^7 cells•ml⁻¹ of *Chlorella* and 1×10^5, 5×10^5, 1×10^6 cells•ml⁻¹ of *Chlorococcum,* were suspended in 500 ml of nutrient solution containing ¹⁴C-Kepone, pH 7.0. *Chlorella* and *Chlorococcum* were exposed to ¹⁴C-Kepone concentrations of 60.9μg•l⁻¹ (2.17μCi•ml⁻¹) and 59.2μg•l⁻¹ (2.12 μCi•ml⁻¹), respectively. Each cell concentration was replicated 5 times in 125 ml Erlenmyer flasks containing 1′ ⁾ ml of algal suspension. The cells were incubated fo. ⁸ hr at 25°C on a rotary shaker at 80 excursions•m ⁻¹ under a light intensity of 15 μE•m⁻²•sec⁻¹. A complete set of flasks with nutrient solution without algae was also included to serve as a control. At each sampling interval, the flasks were shaken by hand, 4 ml aliquots from each flask were centrifuged at 3000 X g for 2 min, 0.5 ml of each supernatant was added to 3 ml of Aquasol (New England Nuclear), and radioactivity was determined with a Beckman, Model LS-250, liquid scintillation counter. The samples were corrected for quenching and the data are expressed as disintegrations•min⁻¹ (DPM)•ml⁻¹ remaining in solution. An aliquot of the algal cells was counted at the termination of the study and percent increase in cell numbers was calculated.

Efflux of Kepone from algal cells. Aliquots of 4 ml were removed from each of the 5 replicates for each cell concentration of the uptake experiment at the termination of the 48 hr incubation. The cells were harvested from ¹⁴C-Kepone solution by centrifugation at 3000 X g for 2 min and resuspended and washed 3 times with sterile nutrient medium. After washing, the cells were resuspended in 2 ml of sterile nutrient solution, incubated for 20 min under the same conditions used in the uptake study, centrifuged, and ¹⁴C in 0.5 ml of supernatant in 3 ml Aquasol was measured with the liquid scintillation counter. The samples were corrected for quenching and the data are expressed as DPM•ml⁻¹ for each algal cell concentration.

Analysis of data. The data was tested for significance at the 5% level of confidence according to Duncan's Multiple Range Test (Sokal and Rohlf, 1969). All experiments were repeated with results similar to those reported.

Results and Discussion

Influence of Kepone on algal growth. Chlorella growth was inhibited by 2 ppm of Kepone after 24 hr of incubation (Table I). The growth of *Chlorella* was also inhibited by 1 ppm of Kepone during the 48 hr incubation. The growth of *Chlorococcum* was inhibited by 1.5 ppm of Kepone during the 24 hr incubation and by all concentrations of Kepone tested during the 48 hr exposure (Table II). After 96 hr of incubation, *Chlorella* growth was inhibited by Kepone concentrations greater than 0.5 ppm, but the growth of *Chlorococcum* was only inhibited by the highest concentration, indicating recovery from the Kepone effect.

TABLE I

Effect of Kepone on Growth of <u>Chlorella</u>

Kepone (ppm)	Cells X 10^{-5}/ml[a]			
	Hours of incubation			
	12	24	48	96
0.0	2.0 a	5.8 a	38 a	357 a
0.0 + Acetone[b]	1.9 a	5.4 ab	35 ab	356 a
0.5	1.9 a	5.8 a	30 bc	324 ab
1.0	2.0 a	4.2 ab	27 c	254 bc
1.5	1.9 a	3.8 bc	29 bc	254 bc
2.0	1.9 a	2.6 c	23 c	232 bc

[a] Values in each column are the means of four replicates and those followed by the same letter within each column are not significantly different at the 5% level of confidence according to the Duncan's Multiple Range Test.

[b] Stock solutions of Kepone were prepared with acetone and the same volume of acetone, 0.5 ul/ml, was added as in the Kepone treatments.

TABLE II

Effect of Kepone on growth of <u>Chlorococcum</u>

Kepone (ppm)	Cells X 10^{-5}/ml[a]			
	12	24	48	96
0.0	0.62 a	1.02 a	2.6 a	13.4 a
0.0 + Acetone[b]	0.67 a	0.86 b	2.5 a	12.8 a
0.5	0.60 a	0.80 b	1.8 b	12.4 a
1.0	0.65 a	0.75 b	1.6 b	12.3 a
1.5	0.60 a	0.60 c	1.1 c	9.0 a
2.0	0.60 a	0.60 c	0.6 c	2.6 b

[a] Values in each column are the means of four replicates and those followed by the same letter within each column are not significantly different at the 5% level of confidence according to the Duncan's Multiple Range Test.

[b] Stock solutions of Kepone were prepared with acetone and the same volume af acetone, 0.5 ul/ml, was added as in the Kepone treatments.

These results show that Kepone reduced the rate of algal growth. The concentrations of Kepones and algal cells used in these experiments were greater than those found in the James River (United States Environmental Protection Agency, 1978). Lower concentrations than those used in this study of various other chlorinated hydrocarbon pesticides were toxic to algae (de la Cruz and Naqvi, 1973; Vance and Drummond, 1969; Wurster, 1968; Menzel et al., 1970; Butler, 1963); however, Hollister et al. (1975) found that Mirex, a compound with molecular structure similar to Kepone, did not affect growth when various species of algae were

exposed to 0.2 ppb. Growth of algae in the James River may be affected by the Kepone contamination, especially in shallow water (up to 60 cm deep) locations containing the higher concentrations (1 ppm up to 10 ppm in the bottom sediment).

Effect of Kepone on respiration. Respiration of *Chlorella* and *Chlorococcum* was reduced by 47 and 37%, respectively when cells were exposed to 1 ppm of Kepone for 96 hr (Table III). These results support observations of de la Cruz and Naqvi (1973) that 1 ppm of Mirex inhibited respiration of *Chlamydomonas.*

TABLE III

Effect of Kepone on Respiration

| Kepone (ppm) | μmol O_2 Consumed $(mg\ dry\ wt)^{-1}/hr$[a] | |
	Chlorella	Chlorococcum
0.0	32 a	99 a
0.0 + Acetone[b]	36 a	92 a
1.0	19 b	58 b

[a] Values in each column are the means of five replicates and those followed by the same letter within each column are not significantly different at the 5% level of confidence according to the Duncan's Multiple Range Test.

[b] Stock solutions of Kepone were prepared with acetone and the same volume of acetone, 0.5 μl/ml, was added as in the Kepone treatments.

Mitochondria have many important roles in plant and animal cells and are a source of energy for metabolic functions. Chronic influences of various pesticides has been shown to interfere with cellular functions (Pardini et al., 1971). Mitochondrial membranes, as well as other cellular membranes, contain a high content of phospho-lipids. Since organochlorine pesticides are lipid-soluble, it is expected that cellular membranes absorb a high concentration of these chemicals which interfere with mitochondrial function (Pardini et al., 1971). Some of the pesticides which inhibit respiration are heptachlor, chlordane, toxaphene, rotenone, Mirex and Kepone (Pardinia et al., 1971; Byard et al., 1975; Anderson et al., 1977; Anderson et al., 1978; Desaiah and Koch, 1975; Desaiah et al., 1977).

Since Kepone inhibits the animal ATPase, lactate, malate and glutamate dehydrogenases *in vitro* (Desaiah et al., 1976; Anderson et al., 1978; Anderson et al., 1977; Freedland and McFarland, 1965) it is probable that Kepone affects these same enzymes in plant cells.

Effect of Kepone on photosynthesis. Kepone at 1 ppm reduced rates of photosynthesis of *Chlorella* and *Chlorococcum* 17 and 10%, respectively, after 96 hr. of incubation (Table IV). Effects of chlorinated hydro-

TABLE IV

Effect of Kepone on Photosynthesis

| Kepone (ppm) | μmol O_2 Evolved $(mg\ chlorophyll)^{-1}/hr$[a] | |
	Chlorella	Chlorococcum
0.0	66 b	34 a
0.0 + Acetone[b]	76 a	34 a
1.0	63 b	31 b

[a] Values in each column are the means of five replicates and those followed by the same letter within each column are not significantly different at the 5% level of confidence according to the Duncan's Multiple Range Test.

[b] Stock solutions of Kepone were prepared with acetone and the same volume of acetone, 0.5 μl/ml, was added as in the Kepone treatments.

carbons on photosynthesis of algae have been previously documented, but the mechanism is not understood (Menzel et al., 1970; de la Cruz and Naqvi, 1973). Some reports suggest that chlorinated hydrocarbons inhibit the Hill reaction (Butler, 1963, Wurster, 1968; Södergren, 1968).

Chlorella at a concentration of 2.54×10^7 cells•ml[-1] exposed to 1 ppm of Kepone was equivalent to $0.4 \times 10^{-7} \mu g$ Kepone in the water for each cell. While information was not found on populations of algae throughout the James River, information was available on cell populations in the Hampton Roads area and chlorophyll *a* concentrations in the James River. Marshall (1967) found that populations of algae in the Hampton Roads area were approximately 200 cells•ml[-1] during the summer months. Chlorophyll *a* content in the James River ranged from less than 10 μg•l[-1] near Hampton Roads to more than 40 μg•l[-1] near Hopewell, Virginia (United States Environmental Protection Agency, 1978). Assuming cell concentration as a direct function of chlorophyll content, cell populations ranged from 200 to 800 cells•ml[-1]. Sampling of the James River water revealed Kepone concentrations from as high as 0.042 μg•l[-1] to less than 0.006 μg•l[-1] (United States Environmental Protection Agency, 1978). The amount of Kepone in the river water was calculated to range from $2.1 \times 10^{-7} \mu g$ to $7.5 \times 10^{-9} \mu g$ Kepone for each algal cell in the James River. The $0.4 \times 10^{-7} \mu g$ Kepone in the water for each cell in these studies is within the range found under natural conditions and thus it appears that Kepone may reduce photosynthesis and probably growth of algae in the James River.

Amount of ^{14}C-Kepone removed from solution. *Chlorella,* at concentrations of 1×10^6, 5×10^6, and 1×10^7 cells•ml[-1] removed 13, 40 and 57% of Kepone from solution, respectively, after 30 min of incubation (Fig. 1) indicating that the removal of Kepone was dependent upon cell concentration. *Chlorella* cells showed a significant efflux of Kepone during longer incubations.
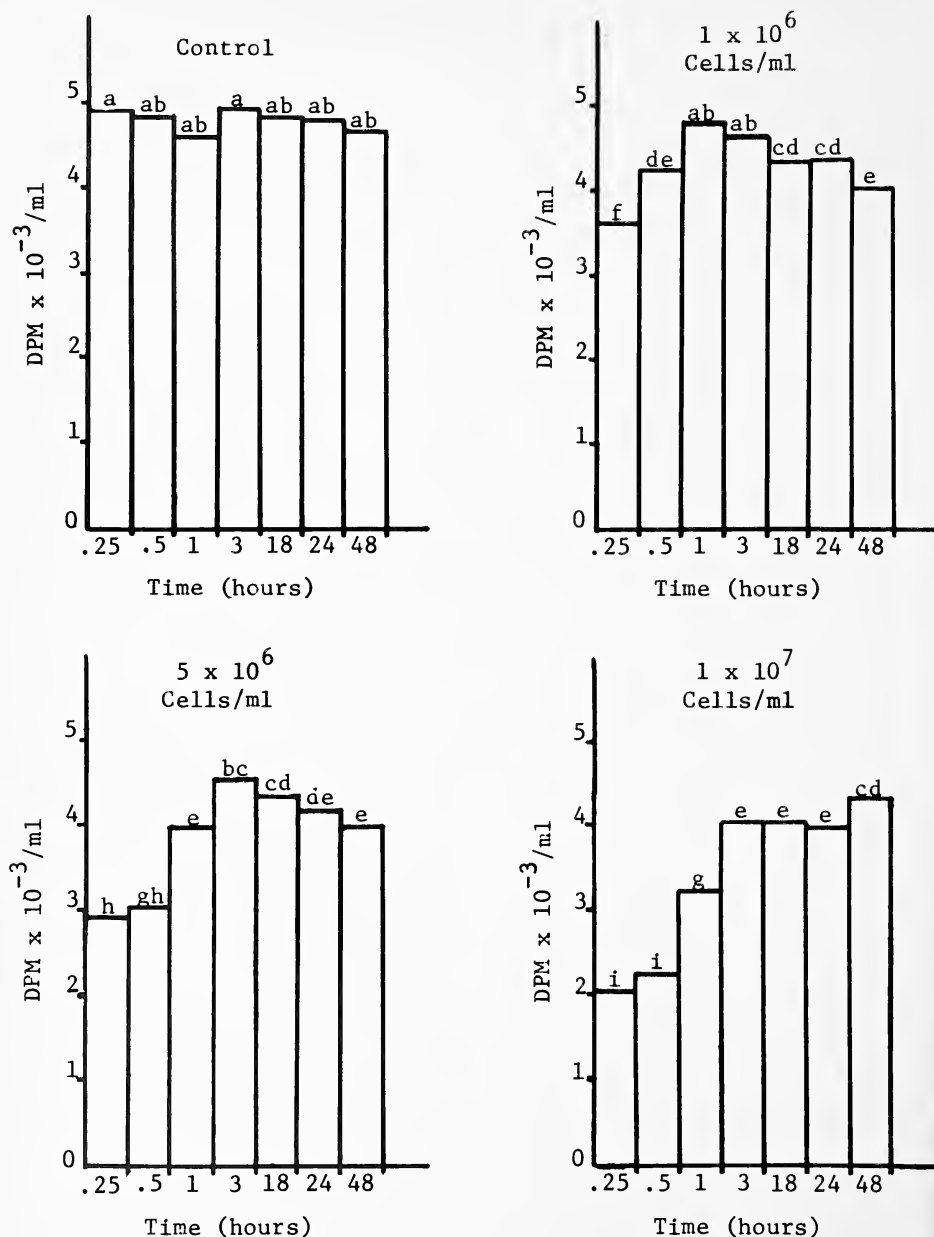
FIG. 1—Amount of ^{14}C-Kepone remaining in solution after uptake by *Chlorella* over a 48 hr sampling period. All bars with the same letter are not significantly different at the 5% level of confidence according to the Duncan's Multiple Range Test.

The rates of efflux peaked at 1 and 3 hr incubations at the lower cell concentrations, but continued during the entire 48 hr period at the highest cell concentration. The lower cell concentrations of *Chlorella* removed Kepone from solution at a steady rate after 3 hr of incubation until the experiments were terminated. This may be related to algal growth resulting in higher cell concentrations (Fig. 2). The amount of Kepone removed in 48 hr by each of the cell concentrations, 1×10^6, 5×10^6, and 1×10^7 cells•ml^{-1} was 17, 17 and 10%, respectively.
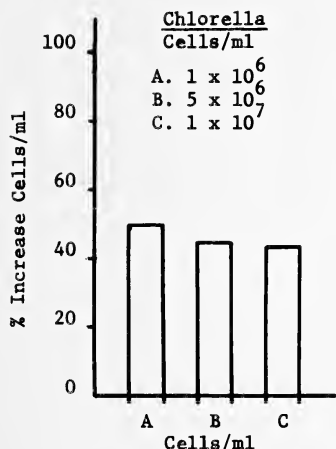
FIG. 2—Percent increase of *Chlorella* cell number during uptake study over 48 hr.

Chlorococcum cells did not demonstrate the efflux of Kepone observed with *Chlorella* except at the 1×10^6 cells•ml^{-1} (Fig. 3). It appears that an equilibrium of Kepone with the algal cells was reached rapidly. A trend toward continued removal of Kepone was evident in the later sampling interval; however, this may have been due to increased cell number (Fig. 4). *Chlorococcum* at 1×10^5, 5×10^5, and 1×10^6 cells•ml^{-1} removed 8, 40 and 57%, respectively, of the Kepone from solution.

The reason for Kepone efflux was not completely resolved; however, equilibriums between adsorption/desorption and absorption are probably involved. Many organochlorine insecticides have adsorptive properties (Acree, 1963) and Kepone has a high affinity for organic material (United States Environmental Protection Agency, 1978). Adsorbed Kepone may be desorbed when the pH of the medium becomes more alkaline. It is not known if the pH of the medium
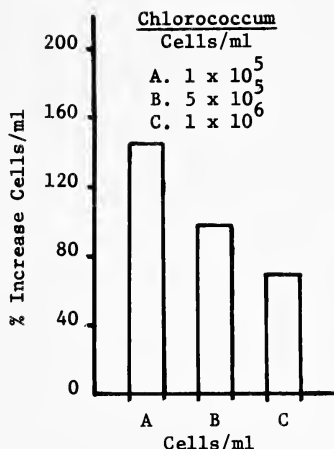
FIG. 4—Percent increase of *Chlorococcum* cell number during uptake study over 48 hr.

changed during these incubations; however, algal cells normally do increase the pH of the medium during photosynthesis. Kepone levels in the James River water peaks at a time when algal and phytoplankton reach peak growth.

Absorption may occur actively or passively and is a physical and complex physiological process in which photosynthesis and respiration play an important role (Hill et al., 1967). Lipid-soluble materials move through cell walls and membranes. This penetration is due to lipid and water solubility of the substance with the lipid solubility determining the extent of penetration. A substance which has a higher lipid than water solubility will move from the water phase to the lipid phase (Södergren, 1968). The solubility of Kepone in water is approximately 2.0 ppm at pH 7. Its solubility in lipids is quite high, but the actual quantity is not known (United States Environmental Protection Agency, 1978). Algae are approximately 20% lipid on a dry weight basis (David M. Orcutt, Unpublished data); therefore, the rapid initial uptake plus the high lipid solubility of Kepone suggests that absorption may be quite important in Kepone uptake. Kepone inhibits photosynthesis, respiration and various enzymes and an alteration of the metabolism of *Chlorella* by Kepone may have caused the efflux of Kepone.

Efflux of Kepone. The data (Fig. 5 and Fig. 6) show that a portion of the activity associated with algal cells was not bound and was released into solution indicating that Kepone was absorbed by algal cells, affected respiration reducing energy level associated with membranes, and released back into the medium. If absorption was the only mechanism of uptake, the
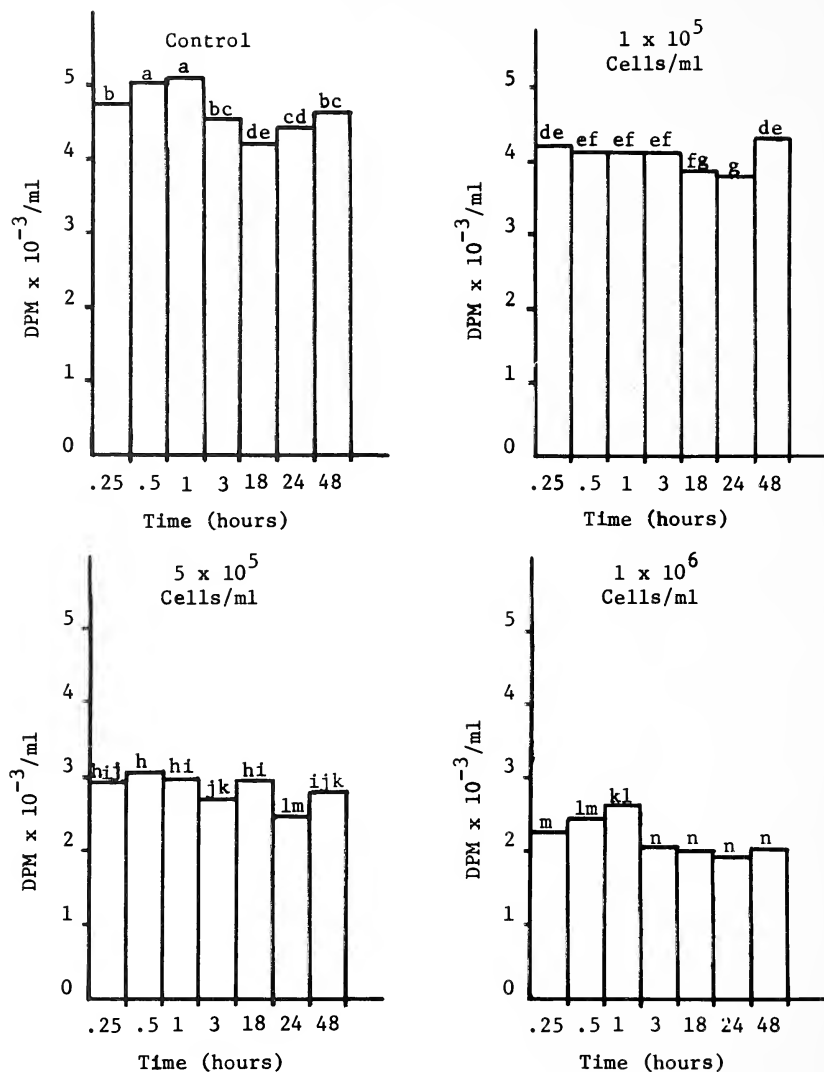
FIG. 3—Amount of ^{14}C-Kepone remaining in solution after uptake by *Chlorococcum* over a 48 hr sampling period. All bars with the same letter are not significantly different at the 5% level of confidence according to the Duncan's Multiple Range Test.
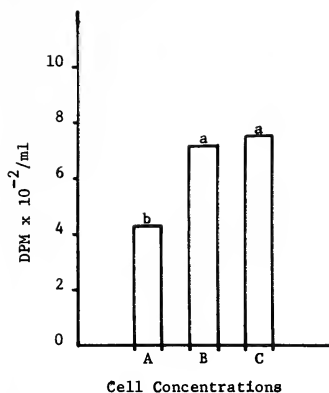
FIG. 5—Efflux of ^{14}C-Kepone after 48 hr from *Chlorella* cells. Cell concentrations, A, B, C, refer to final cell counts, A(6×10^6), B(2.85×10^7), and C(5.96×10^7), centrifuged from 4 ml of treatment solution and placed in 2 ml of nutrient solution without labeled material. $^{a/}$Bars with the same letter are not significantly different at the 5% level of confidence.
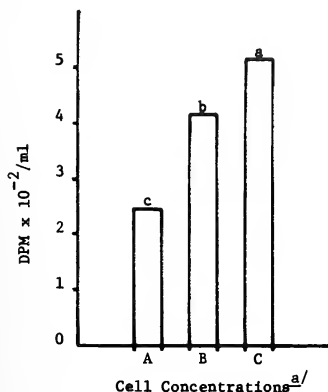
FIG. 6—Efflux of ^{14}C-Kepone after 48 hr from *Chlorococcum* cells. Cell concentrations, A, B, C, refer to final cell counts, A(9.9×10^5), B(4.0×10^6), and C(6.8×10^6), centrifuged from 4 ml of treatment solution and placed in 2 ml of nutrient solution without labeled material. $^{a/}$Bars with the same letter are not significantly different at the 5% level of confidence.

data would have indicated more Kepone returning to solution. Since photosynthesis was occurring and the pH of the growth medium normally rises, it is also possible that some adsorbed Kepone was released back to the medium. Both absorption and adsorption appeared important in the uptake and efflux of Kepone by alga.

Algae accumulated Kepone to toxic levels from low concentrations (Walsh et al., 1977); however, the data reported here indicate that desorption occurred. Movement of Kepone contaminated algae by flowing water may release Kepone in uncontaminated areas allowing Kepone to become available to clean sediments and accumulation by aquatic organisms.

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Gall Formation and Life History of *Pineus floccus* (Patch) (Homoptera: Adelgidae) in Virginia[1]

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Abstract—In Virginia the primary host of *Pineus floccus* is *Picea rubens* and the secondary host is *Pinus strobus*. All generations reproduce parthenogenetically, and each generation has five instars.

One generation occurs each year on red spruce. This generation consists of the gallicolae or gall formers which inject cecidogen into young spruce buds which form the galls. Adults of this generation have wings and fly to white pine.

Annually there are four generations of wingless insects on white pine. A generation appears in March, late May, early July and October. Adults of the October generation overwinter on pine, and deposit eggs which develop into both wingless and winged forms. Those without wings remain on the pine, and those with wings fly to spruce and deposit eggs on young spruce buds. These eggs develop into the gallicolae.

Introduction

This article presents information on the role of *Pineus floccus* (Patch) in the development of galls on red spruce, *Picea rubens* (Sargent), its primary host in Virginia, on the life cycle of the insect on red spruce and on its secondary host, eastern white pine, *Pinus strobus* (L.), and on the presence of cecidogen in the insect and in gall tissue.

It is likely that the substance stimulating gall formation in the red spruce is cecidogen, and for convenience will be called that in this report. Earlier studies by Lewis and Walton (1958) showed that the cone gall of witch hazel. *Hamamelis virginiana* (L.), resulted from the injection of cecidogen into the plant by the aphid *Hormaphis hamamelidis* (Fitch). Later these authors (1964) stated that leaf galls on hackberry, *Celtis occidentalis* (L.), were caused by the injection of cecidogen into the leaf by a psyllid *Pachypsylla* sp. Unpublished studies (by I. Lewis and L. Walton) of galls caused by mites, midges, wasps, aphids and other arthropods demonstrated the presence of cecidogen in both insects and gall tissue.

Cecidogen occurs in amorphous masses, crystals or granules. It may change from one form to another. Cecidogen replicates in the insect, is injected into the plant and is found in vacuoles in the tissues of both. This material is virus-like, and very similar to viruses found in kataplasmic galls. The crystals are diagnostic and are Feulgen-positive.

Materials and Methods

Investigations on *Pineus floccus* (Patch) began in 1963 and terminated in 1975. They were carried out in Virginia at Mountain Lake Biological Station, Giles County, elevation 1165 m, and at Danville, Pittsylvania County, elevation 183 m.

Red spruce and white pine grow well in the Mountain Lake area, and between 1935 and 1940 about 25 spruce and 12 pines were planted on the Biological Station grounds. Fifteen more spruce were planted in the 1950's.

Each year from 1966-1974 white pines 30-60 cm high were planted in cans at Mountain Lake in June, and in early July red spruce twigs with galls were placed in bottles of water at the base of the pines. Each plant was then covered with two thicknesses of white cheese cloth supported by a frame. Winged adults emerged from the galls and deposited numerous eggs on the pines. After the eggs hatched the cheese cloth was removed and the spruce twigs were discarded. Each year the infected, potted pines were taken from Mountain Lake to Danville in late August, placed under a plum tree, and observed through the following May. Also, on June 28, 1970, one 60 cm pine was planted on the grounds at Mountain Lake Biological Station, enclosed with spruce galls under white cheese cloth and observed for the next four years.

At Mountain Lake white cheese cloth bags were placed on twigs of pines planted between 1935 and 1940 and spruce twigs with galls containing late instar nymphs were placed in the bags the first week in July. These pines were observed regularly in late July and August, infrequently in October, April and early May. In late May the bags were removed and the pine twigs marked for further observation. Experiments with older pines were conducted from 1965 through 1975. During these years, late in June, infested small twigs of pine and spruce were brought into the laboratory, placed in bottles of water and covered with a beaker. These were observed regularly until late August to determine the number of days required for egg laying, hatching and molting.

Observations were made on insects which developed from eggs laid by adults that over-wintered on the pine. Early in June 1971, infected twigs from the pine tree planted at Mountain Lake in 1970 were brought into the laboratory and placed in water. Winged adults were removed from the pine and placed singly in Petri dishes on damp filter paper with young

[1]Research conducted at Mountain Lake Biological Station and author's home address.

spruce buds, and their behavior was observed.

Permanent mounts were made of both whole insects of all generations and of dissected adults. They were killed in formalin-acetic acid-alcohol (100 cc—50% C_2H_5OH, 6 1/2 cc 40% HCHO and 2 1/2 cc glacial CH_3COOH), dehydrated through a series of alcohols, cleared in clove oil, xylol, and mounted in Canada balsam. The best whole mounts were obtained by fixing and embedding in paraffin, dissolving the paraffin in xylol and clearing in clove oil.

The Gall

The red spruce gall is a terminal or lateral bud gall, and is commonly known as a pineapple gall because of its internal and external resemblance to that fruit. It is protoplasm with a definite morphological pattern.

Red spruce needles are borne on short stalklets whose cells are cortical in nature and an outward extension of the shoot. Between the first mesophyll cells and the stalklets is the intercalary meristem which causes needles to increase in length. As development takes place the abscission layer is formed, comprising a transverse layer two or three cells thick. These cells are at the distal end of the stalklet. A detailed account of the anatomy of fully developed spruce needles was given by Marco (1939).

In the spring winged insects fly from white pine to spruce and oviposit on the swelling buds. The nymphs which develop from these eggs inject cecidogen into the bud between the acute angle at the upper part of the stalklet and the shoot. The cecidogen injected into the plant causes divisions in the epidermal cells and the formation of trichomes. The growth of the gall is due to hypertrophy and hyperplasia of the cortical cells of the shoot and stalklets. The nymphs are located and maintain themselves in original cavities formed by narrowed needle bases in the normal shoot. The great radial growth of the shoot pushes the cavities with the insects outward from the central clylinder. Because the gall is formed by an outward proliferation of cortical cells, a partition forms between chambers. Lateral growth of stalklets forms "flaps" which cover the cavity and are irregularly triangular in shape. Their formation is caused by the position of the stalklets on the shoot. In red spruce the needles are arranged in a rising spiral. Any one chamber of the gall is bounded laterally above and below by two other chambers. There is little growth on the side next to the shoot. Cecidogen moves outward in all directions from the point of injection but its distribution is limited as shown by Meyer (1962). It moves through the cortical cells to the shoot and to the surrounding needle stalklets, causing cell divisions in both. Cecidogen can pass through the stalklet abscission layer and into a few cells of the needle. In most galls it does not reach the meristematic tissue of the needle. Needles of galls are only slightly shorter than normal, and since the abscission layer does not develop normally the needles never drop from the galls. Old galls resemble small cones and remain on the tree for several years.

Although most of the growth of the gall is lateral, there is some increase in length. At the time the gall is initiated the bud is less than 1 cm in length, but all galls become larger than this, and some near the top of young trees may reach a length of 10 cm. Galls on red spruce develop in a similar manner to those described on Norway spurce by Plumb (1953), but most galls on red spruce are symmetrical. Nymphs settle on all sides of the bud usually at the base of each needle in the central part of the gall, fewer at its base and apex. A cross section through the center of a gall in June showed six cavities, and a longitudinal section of the same gall showed eight cavities. The cavities are not connected. More nymphs were found in the central cavities.

Although it is difficult to distinguish a very young gall from a bud, the young gall is harder and has more trichomes on the stalklets than the typical bud. Yellow color appears at the base of the needles of the gall and then a great increase in thickness quickly differentiates the two. Late in June red color appears around the outer edge of the "flaps". It is first seen on the side of the gall which is toward the sun, on the south side of the tree. This is where the first openings between the gall "flaps" occur and where the winged females emerge. When the galls open, the tissues begin to deteriorate. As the insects come out, outer tissues become brownish and the discoloration extends inward. Exposure to air, thus drying out, must have something to do with this. The needles remain alive until the cavities open. Fibrovascular bundles are close to the bottom of the cavity. Decay sets in here, and in a few days after the galls open, the needles turn brown.

The gall is formed from a bud that would normally develop into a twig with terminal and lateral buds. If cecidogen does not reach the buds of the gall, the buds will develop the next year. After several years the old galls, from which the twigs developed, may still be located by the thickness of the stem.

Location and Variation in Number of Galls on Red Spruce—Most galls on older trees were found near the top, but on young ones were all over. In the forest as many as 20 galls were found on a 25 cm seedling. The number of galls on a tree varied from year to year. Studies were made on a 91.4 cm spruce planted in 1955. For several years after it was planted it was covered with galls and looked as though it would die. It was still heavily infested in 1964 and was only 1.5 m tall. In 1965 it started growing faster, and by 1975 it had reached a height of 4.57 m. Galls on this tree counted each year from 1965 through 1975, numbered 5 in 1965, 0 in 1966, 1,470 in 1967, 700 in 1968, 232 in 1969, 70 in 1970, 6 in 1971, 300 in 1972, 80 in 1973, 1,096 in 1974 and 117 in 1975. From 1965 to 1975 all spruce in the Mountain Lake area showed similar variation in the number of galls.

The variation in number of galls might be explained in part by the fact that there are wingless insects which remain on the pine and produce winged insects which fly to the spruce in the spring. Also weather conditions

influence the population of gall forming insects. Although the temperature at Mountain Lake may fall to -31.7°C the insects survive as the generation which overwinters on the pine has denser chitin and body fluids than other generations. Low temperatures kill the next generation. A severe cold spell in May 1965 killed all vegetation and probably the developing insects as there were few galls that year.

At Mountain Lake, in the spring of 1971, there was an ice storm which lasted several days and the temperature dropped to -5°C. Winged and wingless nymphs can survive this temperature but few galls were found that year. Nymphs probably died from lack of oxygen. Pine twigs placed in bags in 1970 showed many dead nymphs which normally would have developed in the spring. The pine infected at the same time as the bagged ones and taken to Danville had many living winged and wingless insects in the spring of 1971.

Life History of the Insect

In *Pineus floccus* all generations reproduce parthenogenetically (see diagram). Yearly there is one generation on red spruce and four on white pine. The adults (gallicolae) of the generation on red spruce are winged and fly to the pine. Adults of generations on white pine are wingless except those that develop from eggs laid in March. All insects which overwinter on the pine produce both wingless (progrediens aptera) and winged forms (progrediens alata), and the latter fly to the spruce. Each generation has five instars.

Generation on Red Spruce: Gallicolae or Gall Formers— Alatae fly from pine to red spruce in May. At this time spruce buds begin to grow and pull bud scales away from the base of the bud. The winged forms enter the bud through this space and deposit eggs, usually on the inner side of the needles. As many as ten adults may oviposit in one bud. The eggs develop into the gallicolae or gall formers. In the laboratory the eggs hatch in ten days after deposition. The young nymphs insert their stylets at the base of a needle and as many as five may select the same needle, and are covered by gall tissue. Because the nymphs are concealed, their development cannot be observed. Between the arrival of winged adults on the spruce and the next generation of winged adults, five to six weeks elapse.

Winged adults leave the galls at varying times of the year—July 10 in 1963, 1964, 1967, 1973 and 1975; and July 15 in 1965, 1966, 1968, 1971, 1972 and 1976; and July 1 in 1969 and 1970. Winged forms leave the same gall at different times because all gallicolae in a gall are not in the same instar at the same time.

In a gall 4.5 cm long and 2.0 cm wide, 470 nymphs were found. Most were young Instar 5, some 4 and a few 3. Instars 3 and 4 were found either near the apex or base of the gall. The count was made in late June before the galls opened.

Soon after winged adults are formed, the "flaps" of the galls separate, and insects emerge, carrying wax and exuviae with them. After this, predators and other arthropodes, especially mites, move into the cavities.

Generation on white pine— After leaving the spruce galls, the insects fly around for a day or two, then move to the white pine, settle on needles of the present or previous year's growth and start ovipositing, usually on the upper surface of needles. Several females may lay eggs on the same needle and their heads may point either toward the needle's apex or base. Adults remain over empty eggs after the eggs have hatched. After egg laying was completed, pine needles were collected and the eggs counted. The largest insects laid as many as 160, and the smaller ones 60, but most produced 80 eggs.

In the laboratory uninfested twigs of white pine were placed in water under a beaker with red spruce galls containing winged adults. Most of the winged insects emerged from the galls about 2:00 p.m., walked for some time and then began to fly. They were attracted to light. They flew for a day or two, then settled on a pine needle and after 12 to 24 hours started ovipositing. They continued egg laying for two or three days and lived one day after completing oviposition. As the eggs were deposited the female moved forward. The eggs at the greatest distance from the female hatched first, in 7 to 10 days. The nymphs walked down the needles to the stem, went either up or down the stem, and inserted their stylets at the base of a bundle of pine needles or under a scale on the stem.

In this discussion the first generation of insects that developed on pines taken to Danville, and those at Mountain Lake which had been bagged with galls, are referred to as Generation I (See Diagram). The first 3 instars of Generation I were reared in the laboratory. The first molt took place 7 to 10 days after hatching and the second 10 to 14 days later. On living trees time to first molt was 3 or 4 days, depending on the temperature. Later molts were not followed as Mountain Lake Biological Station closes about August 20. However, return trips in early October indicated that adults of Generation I, instar 5, began laying eggs at Mountain Lake then and later in the month at Danville. These eggs give rise to Generation II. In Danville all instars of this generation were present the first week in November and all were adults by the first of December. These adults spent the winter at the base of pine buds, needle bundles or stem scales.

The time of oviposition of Generation II seems dependent on temperature as it is colder at Mountain Lake than at Danville. In Danville females layed eggs as early as March 8 and as late as the end of March. At Mountain Lake most adults deposited their eggs in late April or early May. Developmental stages of *Pineus floccus* on pine from Mountain Lake and Danville were compared on April 21, 1973. At Mountain Lake only adults of Generation II were found and no wax was present, while in Danville the first three instars of Generation III and alatae had developed.

Eggs laid by adults of Generation II numbered 40 to 60, and usually hatched in 10 days, but it took about 3 days longer in cold weather. Apterous adults of Generation II, young nymphs of Generation III and alatae were attracted to the developing white pine buds and

many moved from the place where they spent the winter or where the eggs hatched. At the time the transparent scales were still on the pine buds but had separated at the apex forming openings. Nymphs entered the buds through these openings. Instars 1, 2, and 3 could be seen through these scales and as the scales fell off more nymphs moved to the developing buds.

The eggs of Generation II which overwintered on the pine, developed into two forms, apterae, wingless Generation III, which remained on pine, and alatae, which flew to the spruce. No differences were evident in these two forms in Instars 1 and 2, but in Instar 3 wing pads were visible in some individuals. The insects which showed no wing pads in Instar 3 were similar to and followed the same pattern of development as all generations on the pine. Those which developed wing pads in Instar 3 followed the same development pattern as similar stages of gallicolae. Both forms matured in May. Winged GIII flew to spruce and deposited eggs in the buds which produced the gallicolae. Wingless GIII layed eggs on pine and formed GIV. In early July winged gallicolae flew back to pine, deposited eggs which became GI. At the same time GIV layed eggs resulting in GV. Both GI and GV layed eggs in early October and produced GII and GVI. These two generations were adults in December and overwintered on white pine. In March, both layed eggs which developed into winged and wingless insects. The winged from both generations flew to spruce and GIII and GVII remained on pine (See Diagram).

Diagram of the Life-Cycle of *Pineus floccus*
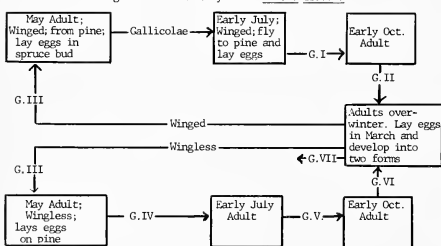
G = Generation

Note - The only generation on the spruce are the gallicolae. All others are on the pine. Generations II and VI produce two forms, winged which fly to the spruce and wingless which remain on the pine and produce GIII and GVII.

All nymphs were removed from a pine bud in May, of 30 examples representing Instar 3 and 4, 28 had wing pads, while 12 nymphs removed from the base of a needle bundle on the same twig showed only one with developing wing pads.

To observe if there were differences between Generations V and I, pine twigs with instars of Generation IV were brought into the laboratory late in June. The twigs were placed in water, eggs were deposited the first week in July and the resulting nymphs observed. No differences were found between these insects and those of Generation I.

In any one generation there may be several weeks difference in the time the adults appear. Generally, eggs for the next generation are laid in March, late May, early July and October. A white pine planted and infected with *Pineus floccus* at Mountain Lake in 1966 was carried to Danville in late August, the same year, and lived through the spring of 1973. During this entire time 273 instars of wingless forms were produced, while 7 generations, one per year, of alatae developed.

Description of the Insects

Mouth organs of all nymphs of all generations are similar. The stylet is needle-like and consists of two pairs of chitinous sheaths, one maxillary, the other pair mandibular. The maxillary pair is firmly interlocked and appears as a single structure. It contains two minute tubes formed by opposing grooves. The dorsal or food canal connects with the pharyngeal pump. The ventral one joins the salivary syringe and is used for the ejection of saliva from the salivary glands. When extended the mandibular sheaths are closely applied to the mandibular pair but are dislodged when the insect is disturbed. In slide mounted specimens three sheaths are visible, one of which is actually a pair of maxillary, the other two single mandibular. When the stylet is not extended the sheaths are coiled in each half of the head.

Gallicolae or Gall Formers on Red Spruce (Numbers are from prepared slides)

Instar 1: Nymphs emerging from eggs laid by alatae are rounded at both ends and have parallel body margins, but as they age the posterior end becomes pointed. The body and appendages are amber in color. Measurements of nymphs are based on a sample of about 15. Nymphs are 0.29-0.32 mm long and 0.17-0.19 mm wide. The ocelli have two facets and are black. The length of the stylet is 0.75 mm and the antennae 0.08 mm. The distal segment of the three-segmented antennae is longest, serrate and constricted ventrally at its proximal end which is rounded.

Instar 2: The body shape is like that of a mature nymph of Instar 1, and it is amber in color. Legs and antennae are dark gray and the 2-facetted ocelli, black. Nymphs are 0.37-0.41 mm long and 0.19-0.21 mm wide. The stylets are 0.97 mm long and the antennae 0.098 mm. Antennae of Instars 1 and 2 are similar.

Instar 3: The cephalothoracic region of nymphs is narrower than the abdomen. They are light reddish brown with dark gray legs and antennae. The nymphs are 0.45-0.6 mm long and 0.29-0.34 mm wide. The stylets are 1.0 mm long and the antennae 0.12 mm. Serrations begin to disappear on the last segment of the antennae. Wax pores appear in this instar. Soon after molting, wax emerges from pores on the head, then the thorax, and still later from the abdomen. The pores are arranged in five longitudinal rows except the head and posterior end of abdomen. Wing pads begin to appear in this stage.

Instar 4: Nymphs are red brown in color with dark appendages, and are much larger than the previous instar, 0.75-1.35 mm long and 0.56-0.64 mm wide. A freshly molted nymph shows only one pair of lateral ocelli, and as it ages compound eyes appear anterior to the ocelli, and three more ocelli become evident at the top of the head. The stylets are 1.2 mm long and the antennae 0.25 mm. Internally the terminal segment of the antennae shows three divisions. Wax pores are prominent, there are four on the head, six on each segment of the thorax, and six on each segment of the abdomen except the last which has four. The pores are arranged in longitudinal rows. Wing pads are prominent.

Instar 5 (Winged Migrants $_1$Gallicolae$_1$ to the White Pine): Freshly molted individuals have bright brown head and thorax with amber wings. In older ones the head, thorax, legs and antennae are black, with amber abdomen and wings. Lateral ocelli persist through the life of the insect, are larger than facets of the compound eyes and protrude laterally beyond the lower part of the compound eyes. Dorsally between the compound eyes are three small ocelli. These are large and small winged forms, 0.875-1.95 mm long and wing span 3.8-5.9 mm. According to Patch (1909), "the wings are rather narrow, 1st A in the forewing curves, the concavity being distad. M of the hind wing curves, the concavity being distad." The stylets of this adult are 0.9 mm long. Antennae are 0.3 mm long and were described by Patch (1909) as follows: "The antennae are characterized by exceedingly large sensoria on joints III, IV, V. Each sensorium comprises the entire surface of the joint except proximal and distal portions and a narrow ridge connecting these. The constrictions between joints are abrupt; III and IV are subequal and V is longer and not as thick.

Patch (1909) also described the wax pores as follows: "Large wax gland areas occur on the head of three thoracic segments. On the abdomen lateral groups are present on perfectly distinct darkened areas on segments I-VII, IV, V, and VI are transversely banded by wax pores across the dorsum. Merged medium groups occur on I, II and III and on III a separate group (sometimes absent) midway between the median and lateral groups."

Generations on White Pine

Instar 1: The amber nymphs are oval when first hatched but later become pointed at the posterior end. They are 0.26-0.33 mm long and 0.15-0.18 mm wide. Two ocelli have three facets each. The stylets are 0.56 mm long. The antennae, .075 mm long and similar to those of Instar 1 gallicolae on red spruce.

Instar 2: The amber nymphs are pointed at the posterior end. Most are 0.33-0.38 mm long and 0.16-0.2 mm wide but some are much larger. The two ocelli have three facets. The stylets are 0.56 mm long and the antennae 0.09 mm and as in 1$_1$gallicolae. Wax pores appear on the head.

Instar 3: When first molted the nymphs are much wider toward the anterior end of the body but as they get older the posterior end expands. They are dark amber and the head is almost black. Nymphs are 0.39-0.41 mm long and 0.22-0.26 mm across the thorax. The ocelli are less prominent than in the first two instars and have three facets. The stylet is 0.7 mm long and the antennae 0.08 mm. There is a reduction in length and diameter of the faintly serrate terminal segment of the antenna. This segment is the same length as the other two segments and has a deep indentation near the proximal end. Large wax pores are present on the upper part of the head and the dark coloration of the area is due to the thickness of the chitin around these pores. Smaller pores are found on the thorax but not on the abdomen.

Instar 4: Nymphs are oval in shape, the head and thorax are dark and the rest of the body is amber. Nymphs are 0.6-0.75 mm long and 0.45-0.6 mm wide. Ocelli have two indistinct facets. The stylets are 1.1 mm long and the antennae 0.04 mm. The wax pores on the head and thorax are arranged in groups with single pores scattered in between. There are five large anterior groups and six smaller posterior groups on the dorsum of the head. Each segment of the thorax has a pair of lateral pores and six submedian ones. All pores differ in size from prothorax to metathorax. Each segment of the abdomen, except the last, has a pair of lateral pores, which decrease in number of facets toward the posterior end. The group of median pores are larger on the anterior segments.

Instar 5 (Wingless Adults which Remain on White Pines): The adult is almost circular with a pointed posterior end and it is dark brown or gray in color. The dorsal surface is larger than the ventral and the legs do not extend beyond the body. The insect is 0.6-0.75 mm long and 0.45-0.6 mm wide. The ocelli have only one facet. The stylets are 1.5 mm long and the antennae 0.02 mm. The third terminal segment of the antennae is shorter than the other two. The wax pores of the adult are arranged as in Instar 4. Only Instar 5 of this generation secretes wax. It appears as rods first on the head, a little later on the thorax and finally on the abdomen. As the rods increase in length they separate into fluffy filaments. Most of the wax is formed in the anterior region of the head. Secretion of wax begins before egg laying.

Insects Which Overwinter on Pine—All instars of the four generations of wingless insects which occur on the white pine have similar characteristics and life histories. However the insects which overwinter on the pine are slightly larger and wax pores appear in Instar 1. The eggs develop two forms, wingless and winged. Winged forms beginning with Instar 3 follow the same development pattern as similar stages of gallicolae. Antennae, simple and compound eyes and wax pores were like those of Instars 3, 4, and 5 in the galls. They were smaller, 0.6-0.92 mm long, with the wing span of 2.5-3.6 mm. Winged adults produced fewer eggs than adult gallicolae.

**Prevention and Control of Galls on
Ornamental Red Spruce in Virginia**

1. Do not plant red spruce and white pines in the
   same locality.
2. Remove and destroy all galls on the spruce in
   June before the winged insects emerge.
3. Contact sprays may be useless because:
   a. The time in May when the winged forms fly
      from pine to spruce varies from year to year
      depending on the temperatures.
   b. There may be several weeks difference between
      the time when the first and last winged insects
      reach the spruce.
   c. Winged insects go under the scales of young
      spruce buds and are   protected from contact
      poisons.

Acknowledgments

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Phytoplankton Studies Within the Virginia Barrier Islands
I. Seasonal Study of Phytoplankton in
Goose Lake, Parramore Island

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Abstract—The phytoplankton of Goose Lake, an oligohaline lake on Parramore Island, was studied for one year. The populations consisted primarily of ultraplankton and nanoplankton sized forms with diatoms and chlorophyceans dominant most of the year. A general pattern of seasonally higher cell concentrations in early summer and fall was noted, with an unidentified ultraplankton sized component prominent throughout the collection period. A list of 154 species is given.

Introduction

Parramore Island is located on the eastern shore of the Delmarva Peninsula in Accomack County, Virginia. It is part of the barrier island complex under the management of The Nature Conservancy and is located approximately 50 km northeast of the Chesapeake Bay entrance (37°32′ N. Lat., 75°37′ W. Long.). Parramore Island is approximately 13.3 by 3 km in size, with its long axis in a general northeast direction. The Island's eastern shoreline is bordered by a parallel series of relict dunes that extend to the island's interior, with elevations up to seven m and a well-developed floral cover. The island topography decreases in elevation along the southern and western margin where the vegetation blends into an extensive salt marsh. Goose Lake has formed between two of these relict dune lines, is finger-shaped and up to 1.5 m in depth, with an area of approximately 0.07km². The size varies with seasonal periods of heavy rain, and the occasional inundation of seawater through the southern end. To the south an earlier channel to Swash Bay and the numerous tidal guts of the bordering marsh have been blocked due to vegetational growth and the accumulation of autochthonous material. During flood periods from storm tides, saltwater entry may occur at this end of Goose Lake. The lake substrate consists of a mixture of silt, sand, detrital material, and various inorganic substances. It is black in color, soft in texture, and its anaerobic state is indicated by the hydrogen sulfide odor common to the bottom samples. More detrital material is found along the shoreline, where a variety of marginal wetland plants are established. A common submergent is *Ruppia maritima*.

Several previous phytoplankton studies have been conducted in the general area of the Barrier Islands. Nearshore phytoplankton, in the vicinity of Assateague Island, was studied by Marshall and Bowker

(1976) regarding the composition and concentration of cells in relation to chlorophyll values. Their samples were dominated by several species of diatoms and the dinoflagellate *Ceratium tripos*, with the diatoms representing 55% of the composition at the station nearest Assateague Island. In a seasonal study of the phytoplankton within the channels of the Barrier Island complex, Marshall, Nesius and Cibik (1980) found *Skeletonema costatum* the dominant species throughout the year. They noted the most common species in these channels were similar to the dominant phytoplankters in the continental shelf waters. A list of summer chlorophyceans and cyanophyceans from Accomack and Northampton Counties was made by Nemeth (1969), but none of his stations were on any of the Barrier Islands. His study emphasized fresh water sites and he recorded 102 chlorophyceans, 43 cyanophyceans, and 15 other species.

Methods

Goose Lake is centrally divided into a northern and southern half by an earthen mound constructed for the placement of a road across the island. Free flow between the 2 halves of the lake takes place through a culvert approximately 0.3 m in diameter placed at basin level. During each of the eight collection trips between October 1978 and October 1979, samples were taken from two stations located in each half of the lake. These surface water samples (500 ml) were preserved immediately with a buffered formalin solution. A settling and siphoning procedure was followed to obtain a 20-ml concentrate which was subsequently examined in a settling chamber with a Zeiss Inverted Plankton Microscope. Salinity readings were taken with a portable Beckman salinometer. The classification used in this report is based mainly on the revisions by Hendey (1974) and Parke and Dixon (1976).

Results and Discussion

Goose Lake is considered an oligohaline lake with generally low saline values ($<5°/oo$). Readings throughout the lake for the collection period indicated rather consistent salinities between 2 and $3°/oo$. Occasionally, storm tide entry will occur from the southern end of

Goose Lake. Such an event was noted by Dr. James Matta of Old Dominion University on 25 October 1978. He took salinity readings at that time that indicated average values of $20^0/_{00}$ in both the southern and northern sections of the lake. By 26 January 1979 the average salinity value for the entire lake had decreased to $2.5^0/_{00}$, where it remained at approximately that level into October 1980, with only slight variations between both sections.

A total of 154 phytoplankters was identified within the samples. The breakdown of species for the various taxonomic groups was as follows: Bacillariophyceae (61), Euglenophyceae (22), Cyanophyceae (18), Dinophyceae (8), Chlorophyceae (21), Cryptophyceae (2), Xanthophyceae (5), Haptophyceae (2), Prasinophyceae (2), Rhodophyceae (1), and one vascular plant *Lemna minor.* The phytoplankton community was dominated throughout the year by various diatoms and chlorophyceans, with various cyanophyceans prominent (see Table 1). Seasonally there were early summer and fall maxima of numbers, with later summer and winter minima. Lowest concentrations occurred during winter (Figure 1).
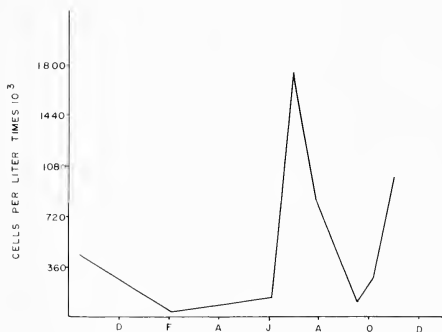
FIG. 1—Average seasonal concentrations of phytoplankton in Goose Lake from October 1978 through October 1979.

The winter phytoplankton possessed two diverse size groups of diatoms. The large cells of *Surirella striatula* and *Tropidoneis lepidoptera* were very common in all the samples with the more abundant smaller diatoms, such as *Navicula salinarum, Amphora coffeaeiformis, Navicula* sp., *Navicula maculata,* and *Nitzschia vermicularis. Nannochloris atonus* was also dominant with several cyanophyceans *(Anacystis marina, A. dimidiata, Oscillatoria submembranaceae),* and the chlorophycean, *Chlorella vulgaris,* common in all samples. Lowest concentrations for the collection period were noted on 2 February 1979 when average cell counts were 67,240 cells/l. One of the dominant species during this period was unidentified, but under light microscopy resembled oocystaceans previously described in the literature (Bourrelly, 1966; Simpson and Van Valkenburg, 1978). This species was round, 4-5u in size, occurring often in groups of four, with what appeared as a "rough" and thickened outer wall.

The spring samples and the early summer bloom consisted mainly of several Pennales diatoms that were less than 30 um in length and several small Centrales forms. *Navicula* sp., *Navicula arvensis, Epithemia argus, Stauroneis anceps* and *Nitzschia amphibia* were found in high concentrations. *Cyclotella meneghiniana* and *C.caspia* were also prominent. Other conspicuous species included *Euglena ehrenbergii, Nannochloris atonus,* and *Kirchneriella lunaris.* High concentrations of green round to irregularly shaped forms, 1.2 to 2.5 μm in size, were in all the spring samples, plus an unidentified Centrales diatom with an average diameter of 3.6μm. The unidentified 1.5 to 2.5 sized "cells" were not included in the cell counts, but easily would have surpassed the other taxa in number. The early summer bloom continued into July with nanoplankton diatoms still dominant. However, the dominant phytoplankton assemblage was diverse in composition. *Chaetoceros debilis, Surirella striatula, Cyclotella striata, Navicula arvensis, Rhabdonema minutum,* and the unknown Centrales *(Cylindropyxis profunda ?)* were abundant. Phytoflagellates included *Trachelomonas hispida, T. volvocina* var. *puncta, Gymnodinium danicans,* and *Phacus longicauda.* There were high concentrations of *Anacystis marina, A. montana minor,* and *A. thermalis.* An unidentified *Scenedesmus* sp. was also abundant with *Nannochloris atonus, Tetraedrom muticum,* and *Kirchneriella lunaris.* The highest concentrations of the study occurred at this time with 1.78 million cells/l recorded on 27 June 1978. During this period there were large concentrations of *Enteromorpha intestinales* common in the benthos in both sections of the lake. The broken fronds of this alga were floating at the surface and part of the phytoplankton community.

The phytoplankton in late summer was dominated by an early bloom of *Cyclotella striata* and *Cyclotella caspia,* with *C. caspia* retaining high concentrations into fall. A mixture of these and other small sized diatoms (< 30 µm) and blue green algae *(Anacystis montana, Nostoc commune, Oscillatoria submembranacea)* dominated the late summer flora. Several *Oedogonium* species were present, with *Lemna minor* (common duckweed) found in high concentrations at the surface in the southern section of Goose Lake. The lowest concentrations for summer were noted in late September with *Cyclotella caspia, C. striata,* and *Nitzschia communis* var. *hyalina* the dominant species.

The early fall period was accompanied by a sharp rise in the nanoplankters, with chlorophyceans, diatoms, and phytoflagellates abundant. The diatoms consisted of mainly *Rhabdonema minutum, Nitzschia closterium, Cocconeis pendiculus, Nitzschia* sp., and *Cyclotella* spp.. The major flagellates were *Chrysococcus minuta,* and *Cryptomonas* spp., with the green algae *Nannochloris atonus, Chlorella ellipsoidea* and *Chlorella vulgaris* also numerous. Of interest was the

presence of several *Euglena* species, mainly composed of *Euglena agilis, Euglena pumila,* and *Euglena ehrenbergii.* In addition, *Phacus* sp. #1 was also common. This seasonal bloom was distinct but smaller in magnitude in comparison to the early summer bloom.

The productivity pattern resulting from phytoplankton growth for the period of study was peak development during early summer (where average counts reached 1.7 million cells per liter on 29 June 1979). A marked reduction followed with a second surge of growth in fall reaching 0.9 million cells per liter on 29 October 1979 (Table 2). The pattern from fall 1978 was a gradual decline into winter, where lowest values occurred in February (67,240 cells/l).

Table 2.
Average cell counts for phytoplankton at stations in the southern and northern sections of Goose Lake during the collection period. Numbers represent cells/liter.

Date	South Section	North Section	Average
13 Oct 78	364,520	539,480	452,000
2 Feb 79	46,600	87,880	67,240
3 Jun 79	174,850	135,330	155,090
29 Jun 79	1,788,800	1,682,400	1,735,600
27 Jul 79	506,480	981,920	744,200
17 Sep 79	142,640	160,280	151,460
1 Oct 79	210,080	432,640	321,360
29 Oct 79	1,029,660	773,760	901,710

The nanoplankton composition has been generally defined by Strickland (1960) as having a size range of 10 to 50 μm, with those forms having sizes between 0.5 to 10 μm as belonging to the ultraplankton. Using this classification, the major phytoplankton components in Goose Lake were the ultraplankton with another major group consisting of nanoplankters in the 10- to 20-μm size category. The more abundant ultraplankton were the diatoms *Cyclotella caspia, Navicula ato-*

mus, and an unknown Centrales diatom; the cyanophyceans *Anacystis marina, A. montana minor, A. thermalis;* the chlorophyceans *Chlorella vulgaris* and *Nannochloris atomus;* the chrysophyceans *Chrysococcus minutus, Ochromonas variabilis, O. miniscula;* the euglenophycean *Trachelomonas volvocina* var. *puncta;* and the xanthophycean *Monodus guttula.* Still not fully addressed are unidentified ultraplankton less than 2.5 μm in size, that were common throughout the year. Further study of this component of the plankton community is needed to more fully ascertain their role in productivity and contribution to various lentic food chains. The dominant nanoplankton were *Cyclotella* spp., and a variety of Pennales forms. Of note were *Rhabdonema minutum, Amphora coffeaeiformis, Cocconeis* sp., and *Nitzschia closterium.* The nanoplankton phytoflagellates were represented by *Cryptomonas* spp., *Trachelomonas* spp., and *Nephrochloris salina.*

The seasonal populations at Goose Lake represented combinations of what are considered typical marine and fresh water species throughout the year, with fewer of the more common fresh water species found in winter. These results differ from composition studies made in the channels of the Barrier Islands and the coastal waters where marine diatoms dominated (Marshall, et al., 1980; Marshall and Bowker, 1976). However, the unidentified ultraplankton component noted in Goose Lake was similar to what Marshall, et al. (1980) reported within the Barrier Island channels. Different population assemblages were also present within the chlorophycean, cyanophycean, and euglenophycean groups in Goose Lake in comparison to those noted on the nearby mainland by Nemeth (1969).

Table 1. Phytoplankton identified in Goose Lake. Seasonal presence is noted with X; the more dominant species are indicated by A, B, C, with A being most abundant.

	W	S	S	F
Bacillariophyceae				
Amphora sp.	–	X	–	–
Amphora coffeaeiformis Kutzing	A	X	–	X
Amphora ovalis (Kutzing) Kutzing	–	–	–	X
Navicula insecta (Grunow) Cleve	X	–	–	X
Caloneis westii (Smith) Hendey	–	–	–	X
Chaetoceros sp.	–	–	X	X
Chaetoceros compressus Lauder	–	–	X	X
Chaetoceros debilis Cleve	–	–	B	–
Cocconeis sp.	–	–	X	X
Cocconeis peniisulus Ehrenberg	–	–	–	B
Coscinodiscus sp.	–	–	–	X
Cyclotella sp.	–	X	X	C
Cyclotella caspia Grunow	–	C	A	A
Cyclotella meneghiniana Kutzing	–	C	X	X
Cyclotella striata (Kutzing) Grunow	–	–	A	B
Cymbella sp.	–	–	–	X
Cymbella ventricosa Agardh	–	–	X	X
Epithemia argus (Ehrenberg) Kutzing	–	B	X	–
Eunotia praerupta Ehrenberg	–	X	–	–

	W	S	S	F
Fragilaria sp.	–	X	–	–
Fragilaria capucina Desmazieres	–	–	X	X
Fragilaria cunrata Skvortzow	–	–	–	X
Fragilaria oceanica Cleve	–	–	–	X
Fragilariopsis cylindrus (Grunow) Helmcke et Krieger	–	X	X	–
Grammatophora marina (Lyngbye) Kutzing	–	–	–	X
Gyrosigma balticum (Ehrenberg) Cleve	–	X	X	X
Licmophora sp.	–	X	–	–
Licmophora paradoxa (Lyngbye) Agardh	X	–	–	–
Melosira granulata (Ehrenberg) Ralfs	–	X	–	–
Melosira granulata angustissima Muller	–	–	–	X
Navicula sp.	C	C	–	X
Navicula amphipleuroides Hustedt	–	–	–	X
Navicula arvensis Hustedt	X	B	B	–
Navicula atomus (Kutzing) Grunow	–	X	X	–
Navicula hennedyi W. Smith	–	X	–	X
Navicula hasdroca Brebisson	–	X	–	–
Navicula inovata Greville	X	–	X	–
Navicula lanceolata var. *fugilis,ta* (Kutzing) Cleve	–	–	–	X
Navicula maculata (Bailey) Cleve	C	–	–	X
Navicula plombica Gregory	–	X	–	X
Navicula salinarum Grunow	A	–	X	X

Table 1. (continued)

	W	S	S	F
Nitzschia sp.	-	X	-	-
Nitzschia amphibia Grunow	-	X	X	X
Nitzschia clausii Hantzsch	X	C	X	X
Nitzschia closterium (Ehrenberg) W. Smith	X	X	X	B
Nitzschia commune var. *hyalina* Lund	-	-	C	X
Nitzschia longissima (Brebisson) Ralfs	-	X	-	X
Nitzschia paradoxa (Gmelin) Grun	-	-	X	X
Nitzschia proxima Hustedt	-	-	-	X
Nitzschia sigmaformis Hustedt	-	-	-	X
Nitzschia vermicularis (Kutzing) Hantzsch	C	X	X	X
Pinnularia sp.	-	-	X	X
Pinnularia major (Kutzing) Rabenhorst	-	-	-	X
Pinnularia rectangulata (Gregory) Cleve	-	-	-	X
Plagiogramma staurophorum (Gregory) Heiberg	-	-	-	X
Rhabdonema minutum Kutzing	-	-	C	B
Stauroneis anceps var. *hyalina* Peragallo	-	B	X	-
Surirella fastuosa Ehrenberg	X	-	-	-
Surirella striatula Turpin	B	X	C	X
Tropidoneis lepidoptera (Gregory) Cleve	B	-	X	X
Unknown Centrales species	-	-	A	-

Chlorophyceae

	W	S	S	F
Ankistrodesmus falcatus (Corda) Ralfs	-	-	-	X
Ankistrodesmus falcatus var. *acicularis* (A. Braun) G. S. West	-	-	-	X
Chlamydomonas sp.	-	X	X	X
Chlorella sp.	-	X	X	-
Chlorella ellipsoidea Cerneck	-	-	X	C
Chlorella vulgaris Beyerinck	C	-	X	C
Kirchneriella lunaris (Kirchner) Mobius	-	B	C	-
Nannochloris atomus Butcher	B	A	A	B
Oedogonium sp. #1	-	-	-	X
Oedogonium sp. #2	-	X	X	X
Oedogonium sp. #3	-	X	X	-
Oedogonium pungens Hirn	-	-	X	-
Oocystis sp.	-	X	X	X
Scenedesmus sp. #1	-	-	-	X
Scenedesmus sp. #2	-	-	B	-
Scenedesmus bijuga (Turpin) Lagerheim	-	-	X	X
Scenedesmus quadricauda (Turpin) Brebisson	-	-	X	-
Staurastrum sp.	-	-	X	-
Tetraedron sp.	-	-	-	X
Tetraedron muticum (A. Braun) Hansgirg	-	-	C	-
Unidentified Oocystacean	C	-	-	-

Prasinophyceae

	W	S	S	F
Pyramimonas micron Conrad and Kufferath	-	-	-	X
Tetraselmis maculata Butcher	-	-	-	X

Cryptophyceae

	W	S	S	F
Chroomonas amphioxeia (Conrad) Butcher	-	X	X	-
Chroomonas salina (Wislouch) Butcher	-	-	-	X
Cryptomonas sp.	-	-	-	X
Cryptomonas irregularis Butcher	-	-	-	C
Cryptomonas rostrella Lucas	-	-	-	C
Plagioselmis sp.	-	-	-	X

Chrysophyceae

	W	S	S	F
Calycomonas ovalis Wulff	-	-	-	X
Calycomonas wulffi Conrad et Ruff.	X	-	-	-
Chromulina parvula Conrad	-	-	-	X
Chrysococcus minutus (Fritsch) Nygaard	-	-	-	B
Mallomonas sp.	-	-	-	X
Ochromonas miniscula Conrad	-	-	-	X
Ochromonas variabilis H. Meyer	-	-	B	-

Xanthophyceae

	W	S	S	F
Monodus guttula Pascher	X	-	-	X
Nephrochloris salina Pascher	-	-	-	X
Tribonema affine G. S. West	-	X	X	X
Tribonema minus (Willie) Hazen	-	-	X	X
Tribonema monochloron Pascher et Geitler	-	X	X	-

Haptophyceae

	W	S	S	F
Chrysochromulina minor Parke et Manton	-	-	-	X
Pavlova salina (Carter) Green	-	-	X	X

Euglenophyceae

	W	S	S	F
Euglena sp.	-	-	X	X
Euglena acus Ehrenberg	-	-	X	X
Euglena agilis Carter	-	-	X	C
Euglena deces Ehrenberg	-	-	-	X
Euglena chlorobergii Klebs	-	C	X	C

	W	S	S	F
Euglena fusca (Klebs) Lemmermann	-	-	-	X
Euglena mutabilis var. *mainei* Gojdics	-	-	X	-
Euglena proxima Dangeard	-	-	X	X
Euglena pumila Campbell	-	-	-	C
Eutreptia lanowii Stever	-	-	-	X
Eutreptia viridis Perty	X	-	-	-
Phacus sp. #1	-	-	-	C
Phacus sp. #2	X	-	-	-
Phacus curvicauda Swirenko	-	-	-	X
Phacus Lemmermanni (Swirenko) Skvortzow	-	-	X	-
Phacus longicauda (Ehrenberg) DuJardin	-	-	C	X
Trachelomonas sp.	-	-	X	X
Trachelomonas acanthostoma (Stokes) Deflandre	-	-	-	X
Trachelomonas charkowiensis Swirenko	-	-	-	X
Trachelomonas hispida (Perty) Stein	X	C	B	X
Trachelomonas hispida var. *punctata* Lemmermann	X	-	-	X
Trachelomonas volvocina var. *punctata* Playfair	-	-	C	-

Cyanophyceae

	W	S	S	F
Agmenellum quadruplicatum (Meneghini) Brebisson	-	-	-	X
Anabaena sp.	-	-	X	-
Anacystis aeruginosa Drouet et Daily	-	-	X	-
Anacystis dimidiata (Kutzing) Drouet et Daily	C	X	-	X
Anacystis marina (Hansgirg) Drouet et Daily	C	-	C	X
Anacystis montana minor (Wille) Drouet et Daily	-	-	C	X
Anacystis thermalis (Meneghini) Drouet et Daily	-	-	C	X
Calothrix parietina Thuret	-	-	X	-
Gomphosphaeria aponina Kutzing	-	-	X	-
Johannesbaptistia pellucida (Dickie) Taylor et Drouet	X	X	X	X
Microcoleus lyngbyaceus (Kutzing) Crouan	-	-	-	X
Nostoc commune Vaucher	-	-	C	X
Oscillatoria sp.	-	X	-	-
Oscillatoria lutea Agardh	-	X	-	-
Oscillatoria submembranacea Ardissone et Strafforella	C	X	C	X
Schizothrix arenaria (Berkeley) Gomont	-	-	X	X
Schizothrix calcicola (Agardh) Gomont	-	-	-	X
Spirulina subsalsa Oersted	-	X	X	X

Dinophyceae

	W	S	S	F
Goniaulax diacantha (Meunier) Schiller	-	-	-	X
Gymnodinium sp. #1	-	-	-	X
Gymnodinium sp. #2	X	X	X	X
Gymnodinium danicans Campbell	-	C	C	X
Gyrodinium estuariale Hulburt	-	X	X	-
Protoperidinium sp.	-	-	-	X
Protoperidinium achromaticum (Levander) Balech	-	-	X	X
Protoperidinium pentagonum (Gran) Balech	-	-	X	X

Others

	W	S	S	F
Campsopogan coeruleus Balbis	-	-	-	X
Lemna minor L.	-	-	X	X
Unidentified ultraplankton	X	B	B	X

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Analysis of Site Specificity for Protein Hydrolysis by the Alkaline Protease of *Neurospora crassa*

Lloyd Wolfinbarger, Jr.

Department of Biological Sciences
Old Dominion University
Norfolk, Virginia 23508

Abstract—The specificity of the extracellularly derived alkaline protease from *Neurospora crassa* was determined by hydrolysis of the oxidized B-chain of insulin. The DNP-derivatives and hydrozinolysis products suggest that this serine protease preferentially hydrolyzes peptide bonds on the carboxyl group side of neutral and aromatic amino acids.

Introduction

The ascomycete fungus *Neurospora crassa* is capable of growing on proteins as a sole source of carbon, nitrogen, or sulfur. Under such growth limiting conditions a total of three extracellular proteolytic species are synthesized and secreted into the media. The three proteolytic species have been identified as an acid protease (optimal activity at pH 5-6), a neutral protease (optimal activity at pH 7.0) and an alkaline protease (optimal activity at pH 8-9) (Heininger and Matile 1974, Drucker 1975, and Hanson and Marzluf 1975). The neutral protease is extremely unstable and is quickly inactivated by most purification schemes. The acid protease has not been extensively purified and thus its site specificity for protein hydrolysis has not been determined. The alkaline protease is a serine-protease and has recently been isolated to homogeneity (Price, Wolfinbarger, Drucker, and Marzluf, submitted for publication). We report here that this protease is similar to chymotrypsin in that it preferentially hydrolyzes peptide bonds on the carboxyl-group side of neutral and aromatic amino acids.

Materials and Methods

Enzymatic digestion of oxidized B-chain of Insulin

Determination of the sites of hydrolysis by the alkaline protease was accomplished by combining 5.0 mg of the B-chain of insulin with 0.1 mg purified *N. crassa* alkaline protease and incubating for 30 minutes, at 37°C, in 1 ml of 1% triethylamine buffer (pH 9.0) (Nakanishi and Yamamoto 1975). The reaction was terminated by freezing.

Determination of amino-terminal residues

The amino-terminal residue-amino acids of the peptides liberated by the above enzymatic digestion were analyzed by making fluorodinitrobenzene (FDNB) derivatives of the peptides, acid hydrolyzing them, and subjecting the products to thin layer chromatographic determination. As a control, insulin plus protease (which were not allowed to react) were also derivatized with FDNB.

Specifically, 1 mg of FDNB, in 1 ml of 95% ethanol, was added to the thawed enzymatic digest and shaken at room temperature for 3 hours. The pH was maintained by addition of 1% triethylamine (pH 9.0). At the end of 3 hours the reaction mixture was repeatedly extracted with diethyl ether until the ether extract was clear. The aqueous phase was then acidified with HCl (pH < 2.0) and the resulting precipitate and aqueous phase were then extracted into diethyl ether, taken to dryness over Drierite and KOH, and labeled extracts 2 and 3 respectively.

Extracts 2 and 3 were then acid hydrolyzed in 6 N HCl, at 100°C for 6 hours, in tubes flushed with dry nitrogen prior to sealing. The hydrolysis products were dried in a vacuum over KOH, redissolved in ether, spotted onto cellulose thin layer chromatographic plates (Eastman) and chromatographed in two dimensions using ammonia saturated 1-butanol and phosphate buffer (1.0 M KH_2PO_4 plus 0.5 M K_2HPO_4), first and second dimensions respectively. Identities of the FDNB derivatives were confirmed using known FDNB derivatized DNP-amino acids (Sigma Chem. Co.).

Determination of carboxyl-terminal residues

The carboxyl-terminal amino acid residues of the peptides liberated by the proteolytic digestion of insulin were determined by hydrozinolysis of the peptide fragments. Again a control of nonreacted insulin plus protease was treated in a manner identical to the experimental sample.

In this instance the enzymatic digestion products were lyophilized prior to the addition of 25 mg of hydrazine sulfate. The digestion products, dissolved in hydrazine sulfate, were frozen to -40°C, vacuum sealed in a hydrolysis tube, and heated at 60°C for 16 hours to derivatize the peptides.

At the end of this time the seal was broken and the tubes freed of hydrazine by holding under vacuum over concentrated H_2SO_4 and P_2O_5 for 4 hours followed by high-vacuum drying overnight. The residue in each tube was then dissolved in a minimal volume of distilled water and passed over a column of IRC-50 (H⁺-form). Neutral amino acids were eluted with approximately 15 mls distilled water and the basic amino acids were eluted with 15 ml of 0.1 M ammonium acetate (pH 7.0). Both eluents of each sample were lyophilized and redissolved in Beckman amino acid analyzer buffer. These solutions were then subjected to analysis using a Beckman amino acid analyzer.

Results and Discussion

The DNP-amino acid derivatives obtained were DNP-phenylalanine DNP-proline, DNP-valine, DNP-glycine, and DNP-glutamic acid (Figure 1). The derivatized amino acids found in the extracts 1 (soluble) and 2 (precipitable material) differed only in a quantitative manner except for a small, barely detectable, quantity of DNP-serine found in extract 2—the acid precipitable material. Because of the difficulty in correctly indentifying individual DNP-amino acid derivatives by their respective R_f values we resorted to co-chromatography of experimental samples with known DNP-amino acid derivatives. If we were not correct in identification of a particular DNP-derivative we would obtain additional yellow spots on our TLC sheets. Using this modified procedure we were able to ascertain that the DNP-valine reported here was not DNP-leucine as we had originally thought. (DNP-leucine and DNP-valine migrate close together on the TLC sheet using the solvent systems described in this study.)
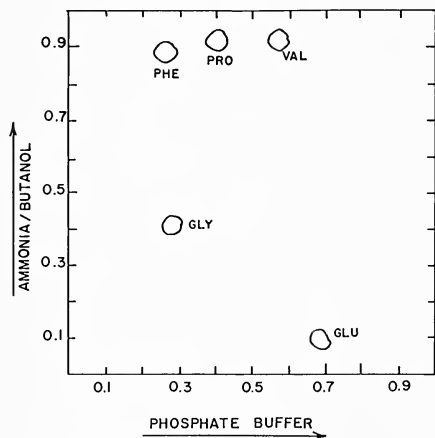
FIG. 1—Thin layer chromatograph of DNP-derivatives obtained from peptide fragments liberated by alkaline protease digestion. In order to normalize each chromatographic analysis the R_f values for each spot were calculated for each solvent system and plotted.

The free amino acid residues remaining after hydrozinolysis of the peptide fragments were determined by use of a Beckman amino acid analyzer (Figure 2). Identities of the eluting ninhydrin positive materials are determined by comparing elution times with the corresponding elution times of amino acid standards. Norleucine is included in the sample application buffer to act as an internal standard for each analysis.

In order to get the DNP-amino acid derivatives indicated in figure 1 the alkaline protease would have
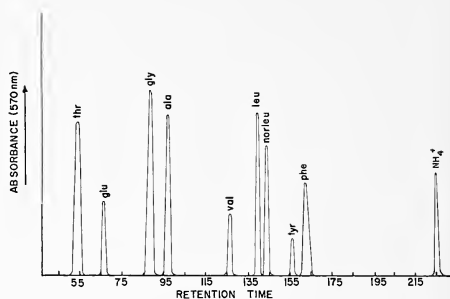
FIG. 2—Amino acid analysis of free amino acids liberated by hydrozinolysis of peptide fragments liberated by alkaline protease digestion. Absorbance is monitored as ninhydrin positive material eluting from the column resin and is presented here without absolute values. The retention time represents the time, in minutes, that each compound remains bound to the column resin. In order to be identified as a specific amino acid its elution time had to fall within one minute of an amino acid standard.

had to cleave peptide bonds on the carboxyl side of residues 1, 3 (minor), 7, 11, 12 (minor), 17, 19, 20 (minor), 22, 23, 24, and 27. The hydrozinolysis products suggest an enzymatic cleavage on the carboxyl side of residues 1, 2 (minor), 6, 8, 11, 12 (minor), 14, 15, 16 (minor), 17, 18 (minor), 20, 21 (minor), 23, 24, 25, 26 (minor), and 27. Evaluation of presumptive cleavage sites common to both the DNP-derivatives and hydrazide-derivatives suggested the following sites of enzymatic hydrolysis: between residues 1 and 2, 11 and 12, 12 and 13 (minor), 17 and 18, 20 and 21, 23 and 24, 24 and 25, and 27 and 28 (Figure 3).
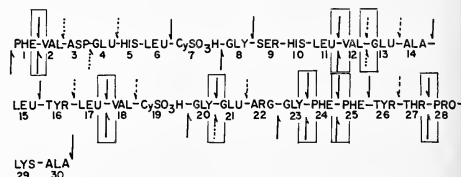
FIG. 3—Cleavage points of oxidized B-chain of insulin by the *Neurospora* alkaline protease. The arrows along the top of the protein fragment reveal presumptive hydrolysis sites as indicated by the hydrozinolysis products. The arrows along the bottom of the protein reveal hydrolysis sites as indicated by the DNP-derivatives obtained. Sites common to both are "boxed-in". Solid arrows represent major and dashed arrows indicate minor sites of hydrolysis.

Obviously longer or shorter incubation times would yield different peptide fragments and hence indicate different sites for hydrolysis. However, the data does suggest that the *Neurospora crassa* alkaline protease preferentially hydrolyzes peptide bonds on the carboxyl group side of neutral and aromatic amino acids.

In addition, the peptides liberated from the oxidized B-chain of insulin, and presumably from other protein substrates, would be small enough to be transported by the oligopeptide transport system reportedly (Wolfinbarger and Marzluf 1975) present in *Neurospora crassa*. Such transport would be necessary before *Neurospora* could utilize the amino acid residues present in a protein as a source of some required nutrient (Wolfinbarger and Marzluf 1974).

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OBITUARY

John C. Strickland

Dr. John C. Strickland, 65, a specialist in blue-green algae and former chairman of the University of Richmond biology department, died February 23, 1980 in Richmond.

A native of Petersburg, Dr. Strickland was awarded a bachelor's degree from the University of Richmond and earned a master of arts degree and a Ph.D. at the University of Virginia.

He taught biology at the College of William and Mary for three years and then joined the University of Richmond faculty in 1946 as an assistant professor. He was promoted to full professor in 1958 and served as chairman of the department from 1957 until 1965. He remained a professor of biology at UR until his retirement last year.

Dr. Strickland published a number of papers on the classification and culture of various strains of blue-green algae. He was a member of the Virginia Academy of Science, of Sigma Xi, the Botanical Society of America, of the American Society of Plant Taxonomists and of the Society for Economic Botany. He also belonged to the North Carolina and California Academies of Science.
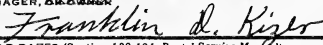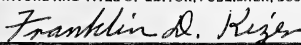
He was a fellow of the American Association for the Advancement of Science and a member of the Phycological societies of America and Britain, the International Phycological Society and the International Association for Plant Taxonomy.

The family suggests that memorial gifts be made to the University of Richmond's Science Library.

VIRGINIA
JOURNAL
OF SCIENCE

THE VIRGINIA JOURNAL OF SCIENCE

Subscription rates for 1980: $15.00 per year, U.S.A.; $20.00 per year, other countries. All foreign remittances must be made at par U.S. dollars or their foreign equivalent. Back issues are available for $4.50 per issue postpaid.

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All manuscripts and correspondence about them should be addressed to the **Editor.** The Virginia Journal of Science welcomes for consideration original articles and short notes in the various disciplines of engineering and science. Cross-disciplinary papers dealing with advancements in science and technology and the impact of these on man and society are particularly welcome. Submission of an article implies that the article has not been published elsewhere while under consideration by the Journal.

The original and two copies of each manuscript and of all figures therein are required. *Authors should submit names of three potential reviewers.* All articles should be typewritten, double-spaced throughout, on one side of good bond paper (8½ × 11 inches). Margins should be not less than 1¼ inches on any border. Each manuscript should be complete and final when submitted. It should include the title, author's name and affiliation, and proposed running title, all appear-

ing on a title page, and a required abstract summarizing the text, particularly the results and conclusions, also appearing on a separate page.

The text should follow the general format used by professional journals in the author's discipline. Literature cited in the text should follow the name-and-year format: Fujishima and Honda (1972), or Spry (1969), or Guliday (1971). On the Literature Cited page at the end of the article each reference should include author(s), year, *title of article,* title of journal (using standard abbreviations), volume number, and first *and last* page of the article. For a book, include author(s), year title, pages or number of pages, and publisher and city of publication. Examples:

Fujishima, A., and Honda, K. 1972. Electrochemical Photolysis of Water at a Semiconductor Electrode. Nature 238: 37-38.

Spry, A. 1969. Metamorphic Textures. Pergamon Press, New York. 350 pp.

Guliday, John E. 1971. Pleistocene History of the Appalachian Mammal Fauna. *In* Distributional History of the Southern Appalachians, Part III. Vertebrates (Perry C. Holt, ed.), pp. 223-262. VPI & SU, Blacksburg, Va.

References to project or company reports, technical memoranda and personal communications are not permitted, except as footnotes under exceptional situations. Footnotes in text should be numbered serially throughout a manuscript.

For illustrations, glossy prints are preferred to drawings. Each figure and table should be mentioned specifically in the text, with all figure numbers and legends typed consecutively on separate sheet, and the figures identified by author's name and figure number in pencil on the back. Table numbers and legends should be included as part of the table.

The VJS reserves the right to make page changes for very long manuscripts, and to bill the authors at cost for unusually extensive complicated illustrative material or extraordinary alterations in the text in proof.

VIRGINIA JOURNAL OF SCIENCE
OFFICIAL PUBLICATION OF THE VIRGINIA ACADEMY OF SCIENCE

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Virginia Academy of Science
Fifty-Eighth Annual Meeting, University of Virginia
May 13-16, 1980

Archives Committee

With regard to the prospect of naming the Virginia Tech Library as the permanent repository for the Archives, the Committee has this recommendation:

1. The Academy should retain ownership of all documents now in its possession, or later directed to the Archives.

2. Records, documents, or other material to be added to the Archives Collection should be channeled through the Committee, rather than directly to the Virginia Tech Library. This will permit the Academy to retain control of the program.

3. The present collection and any later additions should be transferred to the Virginia Tech Library for permanent storage with this understanding:
   a. The Virginia Tech Library is to serve as the "custodian" of the collection until further notice.
   b. At such time as the Academy may choose to relocate its repository for the Archives, the Academy will provide copies of any unpublished material catalogued by the Virginia Tech Library.

4. The Ad Hoc Committee on Archives, in conjunction with administrators at the Virginia Tech Library, will endeavor to jointly develop procedures for use of the Archival material.

Be it further understood that VPI & SU Library will provide a designated area for the housing of VAS documents.

Be it resolved that the aforementioned be referred to the Executive Committee for formal agreement and implementation.

This resolution was passed by Council and referred to the Executive Committee for implementation, with the understanding that the VPI Librarian would also agree to the procedures.

Boyd Harshbarger, Chairman

Awards Committee

The Committee reviewed nominations and recommended to Council election as Fellows of the Virginia Academy of Science: Dorothy Crandall Bliss, Professor of Biology, Randolph-Macon Woman's College; Elizabeth Burger Jackson, Professor Emerita of Natural Sciences, Longwood College; Ralph Addison Lowry, John Lloyd Newcomb Professor of Engineering and Applied Science, University of Virginia and President of the Academy, 1977-1978; James W. Midyette, Jr., Director of Administration, Department of Agriculture and Commerce, Commonwealth of Virginia; Helmut R. R. Wakeham, Vice President, Philip Morris Inc., and Vice President, Science and Technology, Philip Morris USA, Richmond, Virginia.

The Committee proposed and recommended to Council, election as Honorary Life Members in the Virginia Academy of Science, Dr. Mary E. Kapp, Professor Emerita of Chemistry, Virginia Commonwealth University and Dr. Robert F. Smart, Professor Emeritus of Biology, University of Richmond and President of the Academy, 1944-1945, in recognition of their long service and devotion to the Academy.

The Committee proposed and recommended to Council that a special award be presented at the May 1980 meeting to charter member Dr. Leonidas Rosser Littleton, Chemistry Professor Emeritus of Emory and Henry College honoring him in recognition of his 57 years as an active and charter member.

Professor Ruskin S. Freer, Professor Emeritus of Biology, Lynchburg College and President of the Academy 1939-1940, one of the Academy's oldest but still active scientists, was selected as recipient of the Ivey F. Lewis Distinguished Service Award for 1980. His contributions to the Virginia Academy of Science and to science in the Commonwealth of Virginia and beyond are eminently outstanding.

Lynn D. Abbot, Jr., Chairman

Constitution and Bylaws Committee

I. *Constitutional Amendments.* The following were adopted at the 1980 Academy Conference.

Change - 1. ARTICLE III, Section 6. Standing Committees, as follows; Change the words *"Nominating Committee"* to read *"Nominations and Elections Committee"* further, following *"the Constitution and Bylaws Committee,"* insert *"Science Advisory Committee."*

Change - 2. ARTICLE X: ELECTION OF ACADEMY AND SECTION OFFICERS amend to read; Section 1. A "Nominations and Elections Committee," consisting of three recent Past Presidents, appointed by the President shall establish a slate of nominations for the positions of President-elect, Secretary and Treasurer and conduct an election for same in accordance with procedures specified by Academy Bylaws. (See proposed Bylaws)

Section 2. Upon election, such officers shall serve one-year terms commencing at the annual meeting at which their election is announced and continuing until the next annual meeting; pro-

vided, however, the President-elect shall auto-
matically ascend to the position of President at
the end of his scheduled term of office or at any
prior time that the office of President may be
vacated; however, such person shall not serve as
President beyond the term that such person was
originally scheduled to serve.

Section 3. All interim vacancies in Academy offi-
ces, other than President, shall be filled by Coun-
cil from names of members nominated by the
Executive Committee. Officers so selected shall
serve through the next subsequent annual
meeting.

II. *Amendments to Bylaws.* These amendments to the
Bylaws were adopted at the 1980 Academy
Conference.

Change - 1. ARTICLE I: TYPES OF MEMBERSHIP
AND DUES

Section 2. Amend paragraph (5) to read; To be in
good standing the aforegoing types of members
must pay the specified dues by July 1.

Change - 2. ARTICLE III: DUTIES OF STANDING
COMMITTEES

Section 4. Membership Committee shall:

(3) Amend to read; Sponsor a Business Advisory
committee for the purpose of creating under-
standing between science and business, and to
solicit business memberships *and contributions*
to the Academy. *Any business which contributes*
$500 or more annually shall be designated as a
"Sponsoring Organization" and appropriately
recognized as such.

Change - 3. Strike present Section 10 and add following:
Section 10. Nominations and Elections Commit-
tee shall:

(1) Mail to the membership prior to January 1
each year a request for nominations of per-
sons to fill the offices of President-elect,
Secretary and Treasurer.

(2) Nominate a slate of two persons for each of
the aforenamed offices and present to March
Council Meeting for approval.

(3) Mail slate of nominees to members advising
that names may be added to the slate by 25
members petitioning the committee on behalf
of each name to be added.

(4) Prepare ballots with or without additional
nominees as the case may be and mail to
membership with registration and other infor-
mation relative to annual meeting indicating
deadline and address for return to committee.

(5) Count ballots and announce results at the
Academy Conference. Should a tie vote
result for any office, the Academy Confer-
ence shall vote on the nominees. In all cases,
the nominee receiving the largest number of
favorable votes shall be elected; provided,
however, that only members in good stand-
ing may cast ballots.

Change - 4. Add new Section as follows:
Section 13. The Science Advisory Committee
shall:

(1) Provide scientific and technical information
and advice requested by the Executive, Legis-
lative, and other governmental bodies and
agencies of the Commonwealth of Virginia.

(2) Serve as liaison for the collection and transfer
of scientific information and/or advice soli-
cited in (1).

(3) Collect and evaluate suggestions and opin-
ions regarding topics of general public inter-
est wherein science and technology may pro-
vide assistance, but where such assistance has
not been requested. The Science Advisory
Committee will make recommendations to
the Academy, to the Executive Committee,
and/or the Council of the Academy for
review and approval. The Science Advisory
Committee, upon direction of Council or
Executive Committee, shall serve as a con-
duit for placement of such information before
the appropriate Executive, Legislative, or
other governmental body or agency.

(4) Maintain an inventory of scientific interests
and expertise of individuals within the
Academy who are willing to serve in an advi-
sory and/or consultant capacity to state
government.

(5) At no time operate beyond constraints consi-
dered as proper conduct for a non-profit
organization.

(6) Append all reports and recommendations
with a statement as follows; "The Virginia
Academy of Science assumes no legal or
financial responsibility for the utilization or
dispersal of scientific and technical data or
advice provided by the Science Advisory
Committee, further, the Academy assumes
no responsibility, financial or otherwise, to
governmental agents or agencies, institutions,
individuals or committee members pursuant
to the conduct and activities of this committee.

Change - 5. ARTICLE VI: THE DULY ORGAN-
IZED SCIENTIFIC SECTIONS OF THE
ACADEMY ARE:

Stirke; (13) Space Science

Add; (13) Aeronautical and Aerospace Sciences
J. W. Midyette, Jr., Chairman

Finance and Endowment Committee

From the Summary of Receipts and Disbursements
for 1973-79 (Table 1), the following highlights may be
noted regarding our most recent fiscal year ended 31
December:

1. Gift income for the second consecutive year is
about double the average of the last decade and
promises to be even higher in 1980-81. Excep-
tional credit is due the VJAS Committee which is

SUMMARY OF RECEIPTS AND DISBURSEMENTS - 1973-1979

	1973	1974	1975	1976	1977	1978	1979	Budget 1980
RECEIPTS								
Dues	$16,913	$19,631	$18,721	$18,290	$16,352	$16,950	$18,200	$18,100
Gifts	2,276	2,120	2,505	2,130	2,977	5,417	5,327	7,200
Annual Meeting	5,497	4,040	5,323	5,794	5,278	9,164	6,666	6,900
Virginia Journal	4,312	5,168	2,013	1,966	2,568	4,014	2,855	1,650
Interest	1,425	1,618	1,780	2,130	2,223	1,802	2,676	1,800
Inc. from Trust Fund	--	2,039	2,000	2,000	3,000	2,200	2,200	3,300
Other	635	500	676	606	455	674	417	--
From Savings & Others	--	--	--	--	--	1,693	8,398	--
	$31,058	$35,116	$33,018	$32,916	$32,853	$41,914	$46,739	$38,355
DISBURSEMENTS								
Salaries & Benefits	1,914	2,613	2,117	2,475	2,821	3,105	3,385	3,850
General Expense	3,027	3,431	3,254	2,879	2,722	--	3,896	4,470
Meeting Expense	2,575	1,337	2,510	3,248	3,180	3,156	3,415	3,200
Sponsored Programs-Jrs.	8,875	8,706	10,360	9,349	10,880	10,802	11,369	11,535
Va. Journal	12,905	14,401	9,079	10,165	6,049	18,088	21,774	11,650
Committees *	1,000	3,252	2,386	1,825	2,733	3,391	2,900	3,650
Transf. to Savings & Others	762	1,376	3,312	2,975	4,468	--	--	595
	$31,058	$35,116	$33,018	$32,916	$32,853	$41,914	$46,739	$38,355
General Fund Assets 31 December	$34,887	$35,144	$38,455	$41,851	$44,442	$42,749	$34,774	
		$ 2,860	$ 2,000	$ 1,525	$ 2,000	$ 2,429	$ 2,600	
Research Fund Disbursements	$ 2,964	incl.above	incl.above	incl.above	incl.above	incl.above		

* Principally Research & Flora

MEMBERSHIP STATISTICS 1973-1979

Membership Begin. year	1,604	1,563	1,542	1,506	1,426	1,360	1,466
Add	156	237	176	111	93	224	240
Resign & Died	-71	-86	-62	-68	-57	-26	-49
Dropped-Non Pay.	-126	-172	-150	-123	-102	-92	-127
End of Year	1,563	1,542	1,506	1,426	1,360	1,466	1,530
Regular	1,280	1,276	1,233	1,172	1,113	1,165	1,197
Contributing	137	113	110	106	100	100	100
Sustaining	46	43	46	45	46	53	57
Student	63	73	78	61	63	113	139
Life	13	13	13	18	17	16	20
Business	24	24	26	24	21	19	17

responsible for raising about three fourths of its expenditures.

2. Membership is the highest since 1975 with a resulting increase in dues income.

3. On the dark side, the amount withdrawn from savings to meet the budget deficit was $8398. This is the fifth time in 12 years there has been a deficit although the General Fund remains at about $35,000. This is just under the amount set by Council policy of approximately one year's expenditures.

4. Disbursements are the highest since 1968, due mostly to higher Journal costs coupled with an attempt to get Journal publication dates back on schedule with the required number of volumes per year. A vigorous cost reduction effort by the present Editor, Dr. Ware, has resulted in a significant reduction for the four current issues, such that the deficit of last year should not be repeated. There will still be some deficit as a result of publishing more than 4 issues in 1980 to "catch up".

5. Money available to the Research Committee for grants has increased due to rising interest rates paid on Trust funds. Contributions to this trust fund for research of several hundred dollars per year continue to be made by the membership.

6. The historic ratio of VAS expenditures has been approximately equal amounts (1/3) to Jr. programs, the Journal, and all other expenses (Committees, Meeting, and Salaries). Also historically about half our income is from dues.

And now a personal note. Your chairman has asked that he be replaced after nearly a decade on this committee and 14 years on Council. You, the membership, have always responded to our calls for help, financial and otherwise and, through committees, you have been good stewards of the funds we have had. Thank

you for that help and a thank you especially to those who served with me on this committee.

The academy remains a viable and vigorous voice of science in Virginia especially to our young people because of your support as members. Keep up the good work!

D. Rae Carpenter, Jr., Chairman

Flora Committee

The Flora Committee met on May 15, 1980. Those present, including visitors, discussed their work on taxonomic treatments of various plant groups. Dr. L. M. Hill presented his survey on herbarium resources and botanists in Virginia. It will be included in the next issue of Jeffersonia, Volume 11 (2). Dr. Gwynn Ramsey has completed writing of the text of the brochure on careers and avocations in botany. The committee is seeking suitable photographs to illustrate the brochure. Three cost estimates for printing it were obtained: (1) 5000 copies for $400, (2) 1000 copies for $220-240, (3) 2500 copies 8½ × 14″ printed on both sides with pictures and folded for $175-200. Suggested possible sources of money were VAS Finance Committee, Sigma Xi, Forest Product Resource Companies, etc. Dr. Gustay Hall will have his proposed priority listing of threatened and/or endangered plants ready for discussion at the November, 1980, Flora Committee meeting. Dr. Ware noted that there are two plants occurring in Virginia, *Betula uber,* round-leafed birch, and *Panax quinquefolium,* ginseng, that are on the Federal list of protected plants. There was no report on sources of botanical literature.

The Flora Committee agreed to cooperate again with the Botany section in continuing liaison with the Science Teachers Conference held in the fall of each year. The topic this year is "Why Man Explores", Mr. Joseph Exline of the State Department of Education will be contacted in regard to this.

Jeffersonia Volume 10(1) has been issued. Dr. Rex. Baird has updated and computerized the mailing list. The Department of Plant Pathology and Physiology, VPI & SU, was most helpful in getting this issue out. The Flora Committee is very grateful for this assistance.

Dispersement of $150 to Dr. Martin C. Mathes for Louise Mozingo's project on woody flora at the College of William and Mary and of $100 to Dr. L. W. Hill for his work on *Sisyrinchium* was approved by the Committee. The balance in the Flora Committee account after paying the above amounts is $229.30.

Martha K. Roane, Chairman

Membership Committee

The work of the Membership Committee continued in much the same fashion that it did during the past three or four years. It is satisfying to be able to report that at the end of the 1979 calendar year the membership had increased by 64 members over the previous year and had increased 104 over the enrollment of four years ago. As of January 1, 1980 the total enrollment was 1,530 (Table I). It appears that the decreasing membership trend has been reversed and it is hoped that the present trend will be continued.

Two groups were contacted by letter asking that membership be applied for. One of these was the group of people whose names appeared in the program of the annual meeting who were found not to be members. Letters were sent to 455 of these people. The second group were 281 people whose names appeared in the VAS Visiting Scientists Program who were not members of the Academy. These people were asked to add their support to the Academy by becoming members. Copies of these letters are attached.

The Academy brochure was revised and a new supply was made available through the office of the Executive Secretary-Treasurer. A new supply of application forms was also secured. A printout of the addresses of the membership by section was requested to be sent to each section chairman for his use in screening for prospective members.

Application blanks and brochures were distributed to as many persons as requested them.

The current status of the membership is not known for certain. It is hoped that the 1980-81 membership committee will be at least as successful in attracting members as the 1979-80 committee has been.

Warwick R. West, Jr., Chairman

Publication Committee

The Committee wishes to commend the efforts of the editor of the *Virginia Journal of Science,* Dr. Stewart A. Ware, in his attempts to return the publication schedule to a current basis and to maintain publications cost within the guidelines proposed by Council.

In order to have sufficient material for each issue, it is important that each member of the Academy consider submittion of items for publication.

The Report of the Editor is reproduced here.

"My official responsibilities as editor of Vol. 30 of the Virginia Journal of Science began 18 months ago in November 1978, but my active term as editor for Vol. 30 did not begin until 7 months ago in October 1979, when the last issue of Vol. 29 was printed by the previous editor. A new printer is being used now, and printing costs are more manageable. In the last seven months we have printed the first and second issues of Vol. 30 (both carrying advertising, thanks to Business Manager Frank Kizer); gotten the combined issues 3 and 4 of Vol. 30 to the printer; and we've also gotten the combined first and second issues of Vol. 31 to the printer. Both of those should be mailed out this summer. Thus, by the time the Proceedings Issue for 1980, (which will be Vol. 31, #4) comes out in the winter of 1980 the *Journal* should be back on schedule.

The editor wishes to express his appreciation to Business Manager Frank Kizer, former President Ulrich, Publications Committee Chairman Wise, President Remsburg, and all the members of the Publications Committee and the Council for their patience and support during this period of difficulty."

John H. Wise, Chairman

Research Committee

During the past year, six research proposals were funded with a total of $2,585. There are two proposals now under consideration. Decisions regarding these will be made within the next month.

With the resignation of Dr. Herbert McKennis, Jr., as Chairman of the Reserarch Committee in February, 1980, only three committee members remain active. They are William L. Mengebier, Dept. of Biology, Bridgewater College, Paul B. Siegel, Dept. of Poultry Science, VPI & SU, and Stuart B. Monroe, Dept. of Chemistry, Randolph Macon College. In spite of his lack of experience with V.A.S. activities, in general, and Research Committee business, in particular, Monroe assumed the position of Committee Chairman near the first of March, 1980. Since Monroe will be on sabbatical leave from R-M.C., Beginning in February, 1981, another chairman will need to be appointed prior to the usual time of administrative changes in the Spring of 1981.

In previous years, there have been five persons, including the chairman, on the Research Committee. Since the resignation of McKennis, there have been only three active members. Therefore, two additional members should be appointed before the committee resumes its duties of screening research proposals. (Question: Must all members of the committee necessarily be selected from faculties of colleges and universities?) It is imperative that active membership on the Research Committee be brought back to five persons, so that these proposals may receive due consideration.

There were only three papers submitted in competition for the 1980 J. Shelton Horsley Award. The papers were reviewed by the Sigma Xi Chapter of West Virginia University, and the winning paper will be announced on Thursday evening, May 15, 1980. The co-authors of this paper will each receive a certificate and a check for $250.

Members of VAS, who seek financial support of their research in the form of small grants (viz., less than $500), should contact:

> Stuart B. Monroe
> Department of Chemistry
> Randolph-Macon College
> Ashland, Virginia 23005
> Phone: 804-798-8372, Ext. 246

This reporter expresses his appreciation to Vera Remsburg, Blanton Bruner and Frank Leftwich for their help in connection with Research Committee activities since March 1, 1980.

Stuart B. Monroe, Chairman

Ad Hoc Committee to Plan Science Advisory System

The past year has been a year of dormancy for many of the ideas and activities of the Science Advisory Committee. However, as is frequently the case, following a period of dormancy comes renewed vigor and growth. Current activities at the Governor's Cabinet Level and the Legislative Committee Level of state government indicates renewed interest in broadening support for and expanded services of a Science and Technology Advisory System in Virginia.

The recent approval by the General Assembly of financial support for a Virginia Resource Information System (VARIS) is a culmination of eighteen months of study and recommendations by the Executive Task Force and the Legislative Subcommittee. A number of the members of the Virginia Academy made significant contributions to the task force report.

Suggested Constitution and By-laws changes to establish a standing Science Advisory Committee have been approved by the membership at the Academy Conference May 15, 1980.

Ertle Thompson, Chairman

Ad Hoc Committee on Science Education

During the past year the ad Hoc Committee on Science Education, in cooperation with the College of William and Mary, Departments of Geology and of Education (Christopher Newport College) co-sponsored a graduate course offering at the 17th Annual Virginia State Teachers Conference.

The Meeting was held at Virginia Beach, VA, October 5, 6, 1979. Twenty-five teachers participated in the special course in earth science: Geology-Marine Science, and nineteen participants successfully completed all requirements for the graduate credit offering.

Plans are under way to continue cooperation with the State Department of Education-Science Service and the Virginia Association of Science Teachers to bring another program to fruition at the 18th Annual Virginia State Science Teachers Conference to be held at Fredericksburg, VA, fall 1980.

In addition to these regular and on-going committee activities, the ad Hoc Committee on Science Education was asked to review and select two high school seniors (and two alternates) to represent the Commonwealth of Virginia at the 1980 National Science and Mathematics Summer Camp (held in West Virginia each year). Selections were made on a consensus of Committee members' review of approximately three dozen submitted applications.

As previously reported, and acted upon by Council, November 11, 1979, the ad Hoc Committee on Science Education formulated a response to Mr. Wayland Jones, State Department of Education, on the matter of recommendations for material to be considered in the matter of certification regulations for science and mathematics teachers, Commonwealth of Virginia.

Virginia C. Ellet
Arthur W. Burke, Jr.
Co-chairmen

Visiting Scientists Program

Work on the 1979-1980 V.A.S. Visiting Scientist Program began in early 1979, with the securing of permission to conduct the program in the secondary schools of the Commonwealth. During April and May

of 1979 commitments were obtained from presidents of colleges and universities in Virginia to pay transportation expenses of faculty members who would be invited to give lectures under the Visiting Scientist Program. Positive responses came from 35 institutions, resulting in a Speaker's List containing over 600 scientists with approximately 1000 lecture topics.

The Speaker's List was mailed to 366 public and private schools and 130 science departments in community colleges in August. Each mailing also included the V.A.S. brochure and a membership application form. In late 1979 the list was sent to each participating speaker. Those participants who are not members of the Academy were provided with a membership form and were urged to join.

Only 25 report-of-visit forms have been received during this academic year, with audience size ranging from 11 to 150.

Abstracts of Papers
Agricultural Sciences

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

METACARPAL AND METATARSAL CHARACTERISTICS OF SOWS AS INFLU-ENCED BY RESTRICTED GROWTH RATE AND ELEVATED MINERAL LEVELS. S. R. Arthur, H. R. Thomas, J. W. Knight, H. P. Veit, R. A. Barczewski, D. R. Notter, K. E. Webb, Jr. and E. T. Kornegay. VPI & SU, Blacksburg, VA 24061

Gilts in this study had previously been fed one of two levels of energy, ad libitum and 75% ad libitum, and one of two levels of calcium and phosphorus, 100 or 150% NRC, from weaning to 100 kg after which they all received a balanced gestation-lactaion diet. Initially three groups of 65 gilts each were selected for the reproductive study. Gilts that failed to display heat, conceive after three matings or became lame during the study were slaughtered. Metacarpals and metatarsals were removed at slaughter, and were weighed, measured and tested for breaking strength, ether extract and ash content. Increasing the mineral level to 150% of the NRC standards produced a metatarsal with thicker (P< .05) walls with a resultant greater (P< .05) breaking strength, but thickness and breaking strength of the metacarpal was not different between mineral levels. Ether extract content of the metatarsal was lower (P< .05) for gilts fed 150% NRC minerals, but the ether extract content of metacarpals was not affected by the mineral level. Energy levels had little effect on the various metacarpal and metatarsal parameters. A comparison of metacarpal and metatarsal parameters revealed that metatarsals were longer and heavier than the metacarpals, but the metacarpals had greater strength. This study will continue for three parities.

EFFECTS OF EARLY NUTRITION ON REPRODUCTIVE PERFORMANCE AND FOOT CHARACTERISTICS OF FIRST PARITY SOWS. R. A. Barczewski, H. R. Thomas, S. R. Arthur, J. W. Knight, H. P. Veit, D. R. Notter and E. T. Kornegay. Dept. of Animal Science, VPI & SU, Blacksburg, VA 24061 and Tidewater Research and Continuing Education Center, Suffolk, VA 23437

The effect of restricted energy and elevated Ca and P levels during growth and development on subsequent feet and leg characteristics and reproductive performance were studied. Feet and leg measurements were taken at weaning. Reproductive data was collected before and after farrowing. Only data from the first parity is included.

Ad libitum-fed sows had wider toes on the hind foot than restricted-fed sows, with no energy effects on the front toes. Total pigs born and the number of pigs alive at 7, 14 and 21 days were decreased when the 150% NRC Ca and P levels were used in combination with ad libitum-fed sows. Pigs farrowed from sows previously fed the 150% Ca and P levels were heavier; however, this difference may be explained by slightly smaller litter sizes. Gilts that had previously been restricted-fed weighed less after farrowing and at weaning than the ad libitum-fed gilts. These results are preliminary and the study is continuing.

FLEXURAL STRENGTH OF ANIMAL BONE. J.L. Baker* and J.H. Wilson*. Dept. of Agricultural Engineering, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

The evaluation of metabolic or endocrine changes in the diet of an animal are incomplete without information as to how the physical properties of bone change. Bone is an important tissue component of the animal body making up 18% of the body as compared to 43% for muscle, 25% skin and fat, 11% for viscera and 3% for nervous tissue. The mechanical properties of bone are determined by the same methods used in studying similar properties of metal, woods, and other structural materials.

One of the most widely used tests of the mechanical properties of bone has been the bending test of a single supported, centrally loaded bone (three-point bending test). Specimens are either bone sections or whole bones. Simple bending test have been used in a variety of experiments. A review of the literature has been conducted and several other tests have been done to correlate a series of data for flexural strength of animal bone. The strength of large animal leg bones (bovine, equine) are similar to that of the adult human femora (11 GPa vs 13 GPa). In addition, tests of bone in bending have revealed that the assumption of neglible shear is invalid. Many data sets reported in the literature may be inaccurate due to this assumption and flexural strength may be reduced.

EFFECT OF BREED COMPOSITION ON YEARLING WEIGHT OF BEEF HEIFERS. Elizabeth T. Barnes and Thomas J. Marlowe. Dept. of Animal Science, VPI&SU, Blacksburg, Va. 24061

Heifer data from a cooperative cattle breeding project with the VA Dept. of Corrections for 1970-75 calf crops at Southampton Correctional Farm (SHCF) and 1973-75 crops at State Farm (SF) were analyzed by L.S. procedures to determine sire breed effect on performance. Sources of V included year, sire breed, year x breed, dam's age and heifer's age. Measurement traits (MT) included ADG, WDA from Wn to 12 and 18 mos, and wt, grade and cond at both ages for 207 and 197 heifers at SHCF and 419 and 369 heifers at SF at 12 and 18 mos, respectively. Breed of sire and year accounted for significant sources of V at both locations in all MT. All crossbreds (XB) outgrew straightbred (SB) controls at both locations. At SHCF, Angus (AA) heifers grew .15 lb per day slower than Hol x Ang or Char x Ang heifers and weighed 49 lb and 74 lb less at 12 and 69 lb and 108 lb at 18 mos. Diff between XB types was 25 lb and 39 lb at 12 and 18 mos in favor of Char x Ang heifers. At SF all XB heifers outgrew the SB Hereford controls by 21% at 12 mo and 12% at 18 mos except Her x Ang. Avg wt of XB's at 12 and 18 mos was 3 lb and 27 lb heavier at 12 and 18 mos, respectively, than the controls. Diff between the best XB and SB controls was 27 lb and 79 lb at 12 and 18 mos. Rank of the heifers by sire breed (H to L) based on 18 mos wt was Simmental (644), Holstein (623), Charolais (597), Brown Swiss (588), Shorthorn (584), Angus (565), and Hereford (518).

RAPID PRODUCTION OF CYLINDROCLADIUM CROTALARIAE MICROSCLERO-
TIA. J. A. Barron and P. M. Phipps*. Dept. of Plant Path-
ology & Physiol., VPI & SU, Blacksburg, VA 24061.

Cylindrocladium crotalariae incites a serious disease of
peanut (Arachis hypogaea L.) in Virginia. Microsclerotia (ms)
of the fungus are preferentially used as inoculum in studies
of this disease in the laboratory and greenhouse. A proce-
dure that ensures rapid and economical production of ms is
presented here. A medium for culturing ms was prepared that
contained; KH_2PO_4, 1.0 g; $MgSO_4$, 0.5 g; KCl, 0.5 g; dextrose,
100.0 g; casein hydrolysate, 0.05 g; agar, 20.0 g; dist. H_2O,
1 liter; and 1.0 ml of a micronutrient solution that supplied
0.05 mg Mg^{+2}, 0.2 mg Zn^{+2}, and 0.1 mg Fe^{+3}. The pH was ad-
justed to 6.5 and the medium was autoclaved (1.05 kg/cm^2 for
0.25 h), poured into 9 cm Petri dishes (25 ml/plate), and
allowed to solidify. A mycelial suspension consisting of two
ten-day-old potato-dextrose agar (PDA) cultures of C. crota-
lariae blended for 1 min in 300 ml sterile H_2O was prepared.
Each plate of medium was inoculated by transferring 5.0 ml
of suspension to the agar surface, then incubated in darkness
at 25 C. After 4 wk, cultures were comminuted for 2 min in a
blendor and the ms were collected on a 38 um sieve. The ms
obtained (ca. 80,000/plate) germinated on PDA at a level of
85% after 30 h and appeared morphologically similar to those
found in the root cortex of C. crotalariae-infected peanut
plants. Peanut plants grown in raw field soil infested with
these ms (30/g soil) exhibited severe disease after 8 wk in
greenhouse tests.

CGA72662 AS A TOPICAL AND FEEDTHROUGH POULTRY MANURE TREAT-
MENT FOR HOUSE FLY CONTROL. Andrew F. Beck*. Dept. of Ento-
moloov, Va. Polytechnic Inst., Blacksburg, Va. 24061
A 10% emulsifiable formulation of Ciba-Geigy CGA72662,
a triazine insect growth inhibitor, was applied topically to
poultry manure in a commercial caged-layer, shallow-pit
house at the following final dosages/200 ft^2 of manure sur-
face: 0.1% (1 gal), 0.1% (2 gal), 0.05% (1 gal) and 0.05%
(2 gal). Manure samples were collected prior to treatment
and for 4 consecutive weeks, and emerging adult house flies/
dry weight of manure sample were recorded. All treatments
showed inhibition of house fly development for 4 wk.
A 3.0% premix of CGA72662 was diluted to 1.5 ppm in
a standard layer diet and fed to 4 batteries of 5 birds each
for 7 days. Four similar batteries were left untreated. A
manure sample from each battery was collected daily from one
wk prior to treatment until one wk after the end of treat-
ment, at which time all samples were seeded with 50 first
instar house flies. The manure of treated birds showed vir-
tually total inhibition of house fly development lasting no
more than 24 h after treatment, and there was no effect on
the number of eggs produced by the birds or the birds' feed
intake or weight gain.

MECHANICS OF THE ANALYSES OF BEEF CALVES' GROWTH AS AFFECTED
BY RALGRO IMPLANTS AND BY CROSSBREEDING. K. P. Bovard and
J. S. Copenhaver, Dept. of Animal Science, VPI & SU,
Blacksburg, VA 24061
Weights in pounds from 151 beef calves at birth, in July
and in September were examined in a series of least squares
(LS) analyses. The data were classified in two years, 1978
and 1979; two sexes, female and steer; two breeds of dam,
Shorthorn and crossbred; two breeds of sire, Hereford and
crossbred, and, four classes of Ralgro implant, a growth
stimulant, namely none, one at birth, one in July, and fin-
ally one at birth and one in July. In particular, the effect
of adjusting for age differences between main classes was
examined. Using October weight as an example, with a mean of
520 lb, the observed standard deviation was 72.0, whereas the
standard error from the LS analysis, fitting for all main
effects and four two-way interactions but ignoring age, was
66.3; including age in the same LS analysis further reduced
the standard error to 50.7. The R^2 value for the former LS
analysis was .225; that for the latter was .551. Calves from
Shorthorn dams had adjusted July weights of 313.6 lb while
those from crossbred dams weighed 345.4 lb. But the latter
class was 9.0 days older than the former. The observed dif-
ference of 31.8 lb (P< .002) was reduced to 12.6 lb (P< .07)
when adjusted for this age difference. Other relationships
were similarly affected.

SUPPLEMENTAL BIOTIN FOR SWINE. II. FOOT CHARACTERIZATION.
K. L. Bryant, J. W. Knight and E. T. Kornegay. Dept. of
Animal Science, VPI & SU, Blacksburg, VA 24061
Three trials using 80 crossbred gilts per trial were con-
ducted to evaluate 220 ug/kg of supplemental biotin to corn-
soybean meal diets for growing-finishing gilts. It was pre-
viously reported that daily gain, daily feed intake, feed
per gain, hair scores and structural soundness scores were
not altered by biotin supplementation. Classification of
all foot lesions were obtained initially and at 45 and 100
kg body weight. Heel and toe erosion and heel cracks were
observed frequently across both treatment groups. Heel
bruises were noted less frequently. There was a linear in-
crease (P< .01) in the incidence and severity of all foot
lesions as the gilts increased in body weight. Less than 2%
of the gilts had heel-sole junction lesions, toe lesions, or
side wall lesions and these were not related to dietary bio-
tin level. Supplemental biotin had no effect on heel and toe
erosion or heel bruising; however, the severity of heel
cracks was reduced (P< .05) by biotin supplementation. There
also was a trend (P< .10) for reduced incidence of heel
cracks when biotin was supplemented. These results suggest
the biotin supplementation may reduce the incidence and
severity of foot lesions, especially heel cracks, without
improving feedlot performance.

SIMULATION MODELS FOR CROP DRYING. C.L. Butts† J.P. Harner†
J.L. Baker† D.H. Vaughan, A.J. Lambert*. Dept. of Agricul-
tural Engineering, Va. Polytechnic Inst. and State Univ.,
Blacksburg, Va. 24061.
Before actual testing of different crop drying methods
are done on a large scale, the drying process should be
modeled to determine its feasibility.
Several computer programs were obtained from various
sources which model the drying process for different drying
methods. Because of increasing energy costs, the method of
particular interest for Virginia was low temperature drying.
These models were adapted for interactive use on the computer
system at Virginia Polytechnic Institute and State Univer-
sity. The programs were run using weather data for the last
fifteen years for four geographic locations in Virginia.
The locations used were: Appomattox, Richmond, Norfolk and
Roanoke, Virginia.
The study shows weather conditions which are favorable
for low temperature drying in Virginia. It was also deter-
mined that low temperature drying can be utilized in
Virginia for grain at moisture contents below 20 percent
without spoilage occurring. Drying from 20 percent down to
a typical safe storage moisture content of about 15 percent
or below can be accomplished in less than three weeks.

UTILIZATION OF FEET AND LEG CHARACTERISTICS AND 16 mm MOTION
PICTURE PHOTOGRAPHY GAIT ANALYSIS AS POSSIBLE PREDICTORS OF
SOUNDNESS IN BREEDING GILTS. D. F. Calabotta, H. R. Thomas,
J. W. Knight, D. R. Notter, M. E. Wright, H. P. Veit and
E. T. Kornegay. Dept. of Animal Science, VPI & SU,
Blacksburg, VA 24061
Models for structural soundness were ascertained utilizing
various feet and leg parameters and gait measurements taken
from 16 mm motion picture photography. At 50 and 100 kg
body weight, 288 gilts were measured for the various para-
meters. All variables were then subjected to a backwards
elimination-stepwise procedure using committee soundness
scores from the appropriate time period, as the dependent
variable. At 50 kg, the best model (R^2=.39) revealed that a
large percent horn and hind leg circumference, large inside
hoof volume, sloping pasterns, high hoof elevation and gaits
which were long in duration, all favored desirable soundness
scores. Conversely, long metacarpals, large outside front
toe areas and large lateral tail movements were undesirable.
At 100 kg, the most desirable model (R^2=.28) included large
inside and outside toes on both the front and hind legs and
sloping pasterns. The best model at 50 kg which could be
used to predict desirable structural soundness at 100 kg
(R^2=.30) included large horn percent, small metatarsals in
relation to tibias, large feet, a long stride and rear legs
which did not greatly deviate at the hock joint. It was
concluded that the larger type hog at 50 kg generally had a
tendency toward unsoundness at 100 kilograms.

BIONOMICS OF THE NORTH AMERICAN AND EUROPEAN OLD HOUSE
BORER Hylotrupes bajulus (L.)(Cerambycidae: Coleoptera).
K.P. Cannon, Dept. of Entomology, VPI&SU, Blacksburg, VA.
24061
    The old house borer, Hylotrupes bajulus (L.), is a
serious structural pest in Eastern North America. The
larvae of this Cerambycid can survive and feed for up to 10
years in seasoned softwood. Since its introduction into
the U.S. over 100 years ago, little work has been done
on the biology of the North American biotype. This study
provides a biological comparison between laboratory
colonies of the N.A. biotype and the European biotype.
    Results obtained from this study indicate that the mean
number of days spent in the prepupal and pupal stages were
not significantly different between biotypes. Comparison
of adult longevity and size indicate significant differences
in size and longevity between sexes but not between biotypes.
There was no significant difference in the mean number of
eggs, mean length and width of eggs and the mean number
of days required for eclosion.

AUTOCORRELATIONS IN FEEDING BEHAVIOR. G.F. Barbato*and
J.A. Cherry. Dept. of Poultry Science, V.P.I. and S.U.,
Blacksburg, Va. 24061.
    The consumption of foodstuffs does not occur at random.
Instead, there is usually a specific sequence of behavioral
responses to food related stimuli. Most statistical tests
assume temporal independence and do not account for
motivational factors, which, in turn, increases the
complexity of analyzing patterns of feed intake. To
account for temporal sequencing, we have adapted time series
analyses, or more specifically, autocorrelation functions,
to explain some of the variation in the feeding behavior
of four populations of chickens. While divergent selection
for body weight did not appear to alter the 24 hour feeding
rhythm of chickens maintained on continuous light, the
sex-linked dwarfing gene, dw, attenuated the cycle,
suggesting a more random pattern of feed intake.

EFFECTS OF A GROWTH STIMULANT AND CROSSBREEDING ON SUCKLING
BEEF CALVES. J. S. Copenhaver and K. P. Bovard. Dept. of
Animal Science, VPI & SU, Blacksburg, VA 24061
    A total of 151 calves was included in the study, with 83
born in 1978; 68 born in 1979. About half of the dams were
straight-bred Shorthorns, the balance were of mixed cross-
breeding among Angus, Hereford and Shorthorn. Half of the
sires used were Hereford; the balance were Simmental-Hereford
crosses. Calves were assigned in nearly equal numbers to
four different combinations of a growth stimulant called
Ralgro, as follows: Class zero served as a control with no
implant; class one received a single 36 mg Ralgro implant in
July, at about 120 days of age; class two received a 36 mg
implant at birth; and class three received two 36 mg implants,
first one at birth and one at about 120 days. A least
squares analysis fitting for year, sex, dambreed, sirebreed,
Ralgro and days of age showed no statistically significant
effects of Ralgro on July or October weights. October weight
for class three, receiving two implants, was 528 lb, 18.5 lb
more (P< .07) than classes one and two, that received single
implants. Calves from crossbred dams were 13 lb heavier in
July (P< .07) than those from Shorthorn cows. In October
the difference increased to 26 lb (P< .03). Calves by cross-
bred sires were 15 lb heavier in July (P< .03) than those by
Hereford sires. In October, the difference decreased to 14
lb (P< .11).

Effects of exogenous progesterone and estrone on conceptus
development, steroid concentrations and farrowing parameters
in swine. D. Lee Dalton and James W. Knight, Dept. of
Animal Science, VPI&SU, Blacksburg 24061.

Gilts administered progesterone (P, .55 mg/kg) and estrone
(E, .275 µg/kg) during early gestation were either hyster-
ectomized (HX) at day 50 of gestation and numerous measure-
ments of conceptus (placenta, fetus, fetal fluids) develop-
ment taken or allowed to farrow. In trial 1, HX gilts
receiving P/E 20-30 (days of gestation) had longer and heav-
ier (P <.01) placentas (PL) compared with gilts receiving
P/E 4-20 and controls receiving corn oil (CO) 4-30. In
trial 1 farrowing group, total pigs born (TPB) was not dif-
ferent among treatments, although live pigs born (LPB) was
lower (P <.05) in the P/E 4-20 vs CO 4-30 gilts. In trial 2,
P/E 12-20 treated gilts had larger (P <.01) PL at HX vs con-
trols (CO 4-20). In trial 2 gilts farrowed, PL weight at
birth (P <.01), TPB and LPB were also greater in P/E 12-20
gilts. At HX in trial 3, P/E 25-30 gilts had larger (P <.01)
PL vs P/E 20-25 or CO 20-30. However, in trial 3 farrowed
gilts, LPB was greater (P <.05) in P/E 20-25 gilts than in
P/E 25-30 or CO 20-30. Other results obtained from HX gilts
included an overall uterine artery minus uterine vein P dif-
ference of approximately 2.0 ng/ml (suggesting conceptus
utilization of P); no trt. or sex of fetus effect on either
P or total protein content of either allantoic or amniotic
fluid; and higher mineral levels in the dried fetuses of
treated vs control gilts.

INFLUENCE OF PSUEDOMONAS SOLANACEARUM AND GLOBODERA SOLANA-
CEARUM ON THE GROWTH OF TOBACCO. W. H. Elmer*, J. B. Jones*,
and L. I. Miller, Dept. of Plant Pathol. & Physiol., Va.
Polytech. Inst. & State Univ., Blacksburg, VA 24061.
    The influence of Psuedomonas solanacearum (PS) and
Globodera solanacearum (GS) on the growth of 'VA Gold' flue-
cured tobacco was studied in the greenhouse. The treatments
included PS, GS, PS + GS and Control (no PS or GS). One
hundred nematode cysts were introduced into GS and PS-free
soil in 10.5 cm pots containing a 2:1 mixture of expanded
shale-silt loam in all GS and PS + GS treatments. A single
2-month-old tobacco seedling was then transplanted to each
pot of all the treatments and grown at 23-27°C. The soil of
pots in which plants had grown for 3 wks in PS and PS + GS
treatments was drench-infested with a 100 ml suspension of
10^{10} bacteria/ml. Eight wks after transplanting the plant
height, floral development and number of new female nematodes
formed was recorded. Plants in the control treatment were in
full bloom and were 4 times taller than plants in GS and PS +
GS treatments in which no blooming occurred. Plants in PS
treatments were 3 times taller than GS and PS + GS treatments
and had a few blooms, but they were significantly shorter
than plants in the Control treatment. There was a 10 fold
increase in the number of nematodes in both GS and PS + GS
treatments and the plants in these treatments were not signi-
ficantly different in growth. The reason as to why plants in
the PS treatment were smaller than in the Control is not known
since no symptoms of Granville wilt of the tobacco were
observed.

AN ECONOMIC INVESTIGATION OF FEEDER PIG PRICE FORMATION
IN VIRGINIA. P. Fisher*, K. H. Baum, S. T. Buccola*,
Dept. of Agricultural Economics, VPI & SU, Blacksburg,
Va., 24061
    A preliminary investigation of feeder pig price forma-
tion in Virginia auction markets during 1975 to 1978 has
indicated a number of interesting economic phenomena.
Data collected included lot size, weight, grade, price per
cwt., date of sale, location, tail docking, order of sale,
and other relevant characteristics. Price comparisons by
weight and season and by grade and weight were developed
through statistical and econometric analysis. Although
the highest pig prices and the lowest sale weights occur
in mid-spring, the economic rationale for this is not yet
apparent. Cost analysis and price summaries indicate that
in most market situations, pigs can be grown from 50 to
65 pounds with larger profits than if sold at 40 pounds.
Limited resource farmers might be able to increase incomes
by becoming aware of seasonal pig price fluctuations and
factors influencing differences in feeder pig prices.

MORPHOLOGY OF MALES OF FOUR ISOLATES OF HETERODERA SCHACHTII.
Lorraine S. Graney and L. I. Miller. Dept. of Plant Pathol.
& Physiol., Va. Polytech. Inst. & State Univ., Blacksburg,
VA 24061.

A comparison was made of the intraspecific variation of
several morphological characters of males of isolates of
Heterodera schachtii from New York (N) and Florida (F) with
cabbage as the host plant and from California (C) and
Michigan (M) with sugar beet as the host plant. Measurements
(in μm) of 30-40 males of the four isolates were as follows.
Body length:N 1075 - 1375 (mean 1201, standard deviation ±
87.0), F 1075 - 1425 (1241 ± 100.0), C 1038 - 1450 (1240 ±
109.7), M 1275 - 1575 (1402 ± 86.0). Stylet length:N 27.0 -
29.0 (28.0 ± 0.6), F 28.0 - 30.0 (29.1 ± 0.8), C 27.0 - 30.0
(28.3 ± 0.7), M 28.0 - 31.0 (29.5 ± 0.7). Dorsal gland ori-
fice to stylet base: N 3.0 - 5.4 (4.2 ± 0.6), F 2.5 - 6.0
(4.1 ± 0.9), C 3.0 - 6.0 (4.8 ± 0.8), M 2.5 - 5.0 (4.0 ± 0.7).
Excretory pore to head end:N 128.0 - 171.0 (151.7 ± 9.8), F
139.0 - 182.0 (162.9 ± 12.4), C 130.0 - 189.0 (162.4 ± 14.0),
M 148.0 - 201.5 (173.4 ± 12.8). Tail length:N 4.5 - 9.0
(7.3 ± 1.3), F 4.0 - 12.0 (7.3 ± 1.9), C 6.0 - 10.0 (8.3 ±
1.2), M 5.0 - 11.5 (8.0 ± 1.8). Tail terminus length:N 2.0 -
5.3 (3.5 ± 0.8), F 3.0 - 7.0 (3.7 ± 0.8), C 3.0 - 6.0 (4.1 ±
0.9), M 2.0 - 5.0 (3.8 ± 0.8). Spicule length:N 29.0 - 33.0
(30.8 ± 1.4), F 29.0 - 36.0 (32.5 ± 1.8), C 30.2 - 37.0
(33.3 ± 1.5), M 31.0 - 37.5 (33.9 ± 1.7). Dimensions measured
for the four isolates overlap and they overlap with published
measurements of H. glycines.

SIX YEAR GROWTH RESPONSE OF NORTHERN HARDWOODS TO CUTTING
TREATMENTS. E. J. Green*. Biometrics Sect., Dept. Forestry
Va. Polytechnic Inst., Blacksburg, VA 24061.

In 1977, a study was performed on the six-year growth
response of northern hardwoods to cutting treatments. The
experiment, located in central New York, consisted of 4
treatments; retention of 0, 30, 60, and 90 ft.^{2} of basal
area per acre on one acre plots. These were applied in a
randomized block design to 4 four-acre blocks (sites).
Additionally, on half of each acre plot, the understory was
removed, while on the other it was left intact.

Analysis of six-year growth data revealed that overstory
stems in the stands cut to 30 ft.^{2} had responsed to release
with significantly higher net basal area growth percents
than stands cut to 60 or 90 ft.^{2}.

Analysis of understory data confirmed that the number of
saplings was inversely related to overstory basal area.
There were more saplings on the better site. Shade intol-
erant white ash displayed a benefit from understory removal,
while other species did not.

HETEROSIS FROM CROSSES AMONG BRITISH BREEDS OF BEEF CATTLE:
STRAIGHTBRED VERSUS CROSSBRED COWS. J. M. Hagerbaumer*,
J. A. Gaines, R. C. Carter, W. H. McClure and W. T. Butts.*
Animal Science Dept., VPI & SU, Blacksburg, VA 24060 and
U.S.D.A.

Longevity of cow, weaning wt. of calf, weaning grade of
calf, percentages of calves born alive and of calves weaned,
average calf age at weaning and kg. of calf produced per cow
year were evaluated in a 7-year phase of a crossbreeding ex-
periment involving straightbred Angus, Herefords, and Short-
horns and all three-way cross calves from F_1 dams. Cross-
bred cows were studied by comparing reciprocal crosses.
Generally speaking, the averages for crossbred cows were
higher than those of straightbred cows for all traits.
Crossbred calves had heavier weaning wts. and higher weaning
grades than straightbred calves (P <.001). Calves sired by
Angus bulls and out of S x H cows ranked first for weaning
wt. and weaning grade. Differences in offspring from recip-
rocal cross dams indicated strong maternal effects on wean-
ling performance. A significant sex x cow cross interaction
for weaning weight suggested differences between the recip-
rocal cow crosses in their ability to respond to the larger
growth potential and increased requirements of steer calves.
Estimates of hybrid vigor for both weaning wt. and weaning
grade were lowest for calves having Hereford maternal grand-
sires and highest for calves having Hereford maternal grand-
dams. Cows with Hereford dams appeared to be the preferred
F_1 combination for a breeding herd.

CIRCADIAN FEED INTAKE PATTERNS IN DIVERSE GENETIC LINES OF
MICE. E.A. Gerken*, W.E. Wyatt*, D.R. Notter* and H.J.
Gerken*. Dept. of Animal Science, Va. Polytechnic Inst. and
St. Univ., Blacksburg, VA 24061.

Twenty-four growing mice from four genotypic lines selec-
ted for high activity (AH), low activity (AL), high serum
cholesterol (CH) and high weight (WH) were fed a laboratory
ration ad libitum. At 45 days of age nine hourly feed in-
take observations were obtained between 8 a.m. and 5 p.m.
Mean hourly intakes for AH, AL, CH and WH, respectively,
were .087, .054, .089 and .119 g/hr. As expected, WH mice
consumed more feed (P<.05), having nearly twice the hourly
feed intake of AL mice. AH and CH mice were intermediate in
feed intake to the other lines. A second set of 24 hourly
observations of feed intake was obtained when mice were 66
days old. During the 24 hr period, mice were subjected to
12 hr of light and 12 hr of darkness. Overall mean hourly
intakes for AH, AL, CH and WH, respectively, were .246,
.243, .244 and .320 g/hr (P<.05). For AH, AL, CH and WH,
means for the 12 hr of light were .169, .144, .138 and .183
g/hr and means for the 12 hr of darkness were .330, .350,
.361 and .468 g/hr. Effects of time of day on feed intake
were significant at both ages. The increase in feed intake
during darkness indicated an increase in eating activity for
all lines during these hours. Also, the change from dark to
light appeared to stimulate feed intake. The interaction
between line and time of day was significant and indicated
that selection had altered the pattern of feed intake.

SOIL-TILLAGE TOOL INTERACTION STUDIES AT VIRGINIA TECH
R. Grisso* and J. Perumpral*, Dept. of Agricultural Engi-
neering, Va. Polytechnic Inst., Blacksburg, VA. 24061.

Information on the factors effecting and their influence
on the performance of a tillage tool is essential for de-
signing more efficient tools. At Va. Tech, approximately
three years ago a research program to study the soil-till-
age tool interaction was initiated. The objective of this
project is to develop generalized mathematical model/s which
include all pertinent soil and tool parameters to predict
the performance of a tillage tool.

Both for developing a clear understanding on the soil-
tool interaction and for the experimental verification of
the models, a soil-bin test facility was designed and con-
structed. The facility consist of a stationary bin, soil
processing carriage, tool carriage, and a hydrostatic drive
system. The stationary bin is approximately 10 meters long,
1 m wide and .3 m deep and was constructed of .35 cm sheet
metal. The soil processing carriage includes a rotary
tiller, strike-off blade and a teflon coated roller to pre-
pare the test section prior to tests. The tool carriage
includes a tool positioning assembly and a six-degree-of-
freedom dynamometer capable of measuring three dimensional
forces and moments on the tool. A servo controlled hydro-
static drive system is used to power the tool carriage.
Test speeds in the range of 0 - 10 km/hr. with different
acceleration and deceleration rates are possible with the
drive system. (Aided by NSF grant).

RELATIONSHIP OF Ca AND K CONCENTRATIONS IN PEANUT SEED TO
GERMINATION. D. L. Hallock and J. L. Steele*, Va. Polytech-
nic Inst. and S. U. and USDA, SEA, Tidewater Res. and Cont.
Educ. Ctr., Suffolk, Va. 23437.

Low Ca contents in peanut seed may affect germination.
Interference of cations such as K with Ca absorption by
fruit may reduce germinability. The relationship between
the concentrations of these cations in the seed and via-
bility was investigated in four experiments in which seed
had developed in varied nutrient environments.

In two Ca-source experiments in 1977 and 1978, the corre-
lation coefficients for the relationship of germinability
versus seed Ca were 0.40** and 0.45** and versus seed K were
-0.08 and -0.43**, respectively. Ca concentrations in the
seed ranged from ca 270 to 620 ppm (447 in 1978) and seed K
from ca 0.70 to 0.90%. Seed germination varied from 76 to
98% in 1977 and from 56 to 85% in 1978.

Correlation coefficients obtained in two other nutrition
experiments in 1978 for germinability versus seed Ca were
0.46** and 0.66**, and versus seed K were -0.37** and
-0.30**. In the latter studies, seed Ca ranged from ca 300
to 675 ppm, seed K from ca 0.70 to 0.90%, and seed germina-
tion from ca 35 to 85%.

Production practices which decrease K and increase Ca
concentrations in seed may enhance germinability and vice
versa. (Aided by Va. Agr. Fdn. grant).

STATE OF THE ART OF SOLAR ENERGY FOR CROP DRYINC. J.P. Harner*, C.L. Butts*, D.H. Vaughan, J.L. Baker*, and A.J. Lambert*. Agricultural Engineering Department, Seitz Hall, VPI&SU, Blacksburg, Va. 24061.

On-farm crop drying in 1974 required approximately 107 x 10^{12} Btu's of energy, or the equivalent of nearly 1.21 x 10^9 gallons of LP gas. In Virginia approximately 2.26 x 10^{12} Btu's (2.52 x 10^7 gallons of LP gas) were used for drying in 1977.

Solar energy has been used in many on-farm crop drying processes, such as for drying corn, peanuts, tobacco, rice, and other crops. The three types of solar collectors normally used are bare plate, covered plate, and suspended plate designs. The bare plate and covered plate designs are the most common for on-farm crop drying. For solar crop drying, air is moved through the collector and then directly to the drying facility. This direct use of the energy eliminates the need for an energy storage facility, which is not economical in most drying systems at present energy prices. Solar heat can increase the drying temperature five to ten degrees, which is adequate for low temperature drying in Virginia in most cases. The pay-back period for the solar collector decreases as the number of different crops dried increases, or as the use period during the year increases. The pay-back period for most systems is less than seven years, while the life of the solar collectors may be as long as twenty-five years, depending on the kinds of materials used.

PREDICTION OF EROSION FROM STRIP MINE SPOIL USINC THE UNIVERSAL SOIL LOSS EQUATION (USLE). E. L. Hockman, Jr.*,V. O. Shanholtz and J.N. Jones*, Dept. of Ag. Engr., Va. Polytech. and State Univ., Blacksburg, VA 24061

Sixteen field plots were located on an active "Mountain Top Removal" mining operation located near Beckley, WV. Each plot was instrumented to measure precipitation, surface runoff and soil loss. Cover percentages and soil erodibilities were also determined. Erosion predictions were then made for each plot using the USLE and the Onstad Modified USLE.

Preliminary results of statistical analysis on accumulated data from storm events from June 4, 1979 to October 3, 1979 indicate both models provided inaccurate estimates of soil loss. For slopes less than 20% no consistant error pattern existed. Estimates for these slopes were significantly less than and greater than the actual value measurement. On slopes greater than 20% the model's predictions were always significantly greater than measured soil loss.

The sediment loads measured from the field plots ranged from .0001 tons/acre for .4 inches of rainfall to 1.4896 tons/acre for 1.53 inches of rainfall.

AN EVALUATION OF INCOME RISK ASSOCIATED WITH VIRCINIA SWINE PRODUCTION SYSTEMS. L. Johnson,* K. H. Baum, Dept. of Agricultural Economics, VPI & SU, Blacksburg, Va. 24061

Swine production in Virginia has become an increasingly important source of income for many Virginia farmers. The choice and level of production of feeder pigs, fat hogs or a complete farrow-to-finish operation and crops can be a critical decision for producer financial stability. In this analysis, a MOTAD (income deviation) analysis of the risk and economic impact of these enterprises were evaluated for a typical farm in the Virginia Tidewater area. A high income level specification selected the farrow-to-finish system as the optimum choice. At lower income levels, feeder pig and finishing enterprises competed with alfalfa hay and corn to minimize income risk. The low income deviation level for the feeder pig system demonstrated its attractiveness to risk adverse producers willing to sacrifice the opportunity for higher incomes.

CROWTH OF WEANLINC LAMBS RECEIVINC THREE DIFFERENT STARTER RATIONS. Nancy Heininger, William H. McClure and Elizabeth T. Barnes, VPI&SU, Blacksburg, Va. 24061, and Southern Seminary Junior College, Buena Vista, Va. 24416

Lamb data from a cooperative lamb rearing project between Southern Seminary Junior College, Buena Vista, and Shenandoah Valley Research Station, Steeles Tavern, were analyzed by L.S. procedure of the Statistical Analysis System. Twelve lambs were assigned to six pens. Lambs were fed milk replacer individually to 20 lbs and allowed alfalfa hay and water free choice during the three-week test period.

Two models were used to analyze weight gain and feed consumption. Sources of V included ration, sex, regression on initial weight, and regression on total milk and ration, sex, regression on initial weight, for Models I and II, respectively.

For Model I only ration and total milk in week 1 (P<.05) for weight gain and ration in week II (P<.01) for feed consumed were significant. For Model II initial weights were significant (P<.05) for all weeks.

A TECHNIQUE FOR THE RECOVERY OF STAND STRUCTURE FROM WHOLE STAND YIELD FORECASTS. D.M. Hyink*. Dept. of Forestry, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

Mathematically, two classic forest growth and yield forecasting techniques are related by: $N \int_{d1}^{d2} g_i(x)p(x;\theta)dx=Y_i$, in which $p(x;\theta)$ is a k parameter probability density function characterizing the distribution of tree diameters at breast height (dbh), $g_i(x)$ is a function relating dbh to a tree attribute such as volume or weight, N is the total number of trees per acre and Y_i is the yield per acre for $g_i(x)$ applied to all trees in the interval bounded by $d1$ and $d2$. Under the diameter distribution approach, the θ_j, j=1,k, are predicted as functions of stand age (A), site index (S), and number of stems per acre (N); and the Y_i is computed as $NE[g_i(x)]$. Conversely, under a whole stand approach, the Y_i's are predicted directly as functions of A, S and N, but no distributional information is available. Presented are two techniques that may provide reasonable first approximations to underlying diameter distributions solely from the results of these whole stand models. If a system of k linearly independent equations, $NE[g_i(x)]-Y_i=F_k(\theta)=0$, i=1, k exists, they may be solved simultaneously for the k parameters, θ. Alternatively, if m such equations exist, (m>k), we may find the k parameters, θ, that minimize $F_m(\theta)^2= (NE[g_i(x)]-Y_i)^2$, i=1,m. In certain cases, the latter method may degenerate to the former.

USE OF PEANUT HULLS IN SOYBEAN PRODUCTION. G. D. Jones* and R. B. Reneau, Jr., Piedmont Research Station, VPI & SU, Orange, Virginia 22960 and Department of Agronomy, VPI & SU, Blacksburg, Virginia 24061.

Peanut (Archis hypogea L.) hulls are a waste product that have potential for increasing soybean [Glycine max (L.) Merrill] yields when recycled to agricultural land as a source of nutrients and as a mulching material. This study was conducted to determine if peanut hulls could be applied at disposal rates and simultaneously increase soybean yields as a result of increased nutrients and moisture in the rooting zone of certain acid soils. Peanut hulls were applied to a Tatum (Typic Hapludult, clayey, mixed, thermic) silt loam soil at rates of 0, 21, 42 and 84 x 10^3 kg/ha on fertilized and unfertilized plots. In 1977 a year of moisture stress peanut hulls increased the yield of seed by 500 kg/ha and forage by 1,560 kg/ha as a result of increased plant available moisture in the fertilized plots. In the unfertilized plots each 1000 kg/ha of hulls produced 21 kg/ha of seeds. In 1978 a year of more optimum conditions 50 x 10^3 kg/ha of hulls were required to equal yields produced with fertilizer application.

INFLUENCE OF A MAMMOTH CHARACTER ON THE PERFORMANCE OF FLUE-CURED TOBACCO (NICOTIANA TABACUM L.). J. L. Jones and T. R. Terrill, Southern Piedmont Center, Va. Polytechnic Inst. and State Univ., Blackstone, Va. 23824.

The mammoth gene causes otherwise day-neutral Nicotiana tabacum to flower only under short photo periods. Two day-neutral cultivars of flue-cured tobacco (Speight G-28 and NC 2326) and their mammoth counterparts were evaluated in field studies in 1979. Leaf number of the mammoth lines was adjusted by removing four bottom leaves and leaving four additional upper leaves to give the same number of harvested leaves as the day-neutral cultivars. Mammoth NC 2326 produced significantly higher yields, a higher quality index, lower total alkaloids, and less priming (P) grades than its day-neutral NC 2326 counterpart. In contrast, Mammoth Speight G-28 gave a lower yield and otherwise performed similarly to conventional Speight G-28.

Age associated changes in swine articular cartilage. G. A. Kesel*, James W. Knight, H. P. Veit, and E. T. Kornegay. Virginia Polytechnic Institute and State University, Blacksburg

Crossbred boars were euthanized at 10 ± 2 days from 80-220 days of age (inclusive) to characterize selected biochemical changes in articular cartilage (AC) associated with age. Total joint surface AC obtained from the distal end of the femur (F) and humerus (H) and proximal end of the radius-ulna (R-U) was characterized following acetone drying. Hydroxyproline (HYP) was measured to indicate collagen content and uronic acid (UA) was measured to indicate total chondroitin sulfate. HYP increased with age. Mean HYP values for boars 80-100 and 220 days of age, respectively, were 71.8 vs 77.3, 72.3 vs 77.0 and 71.8 vs 75.2 mg/g for the F, H and R-U, respectively. Levels of UA in the F decreased between 80-100 (80.2 mg/g) and 220 days of age (76.5 mg/g), while UA in the H and R-U did not differ with age. Results suggest that the collagen content of AC increases and total chondroitin sulfate decreases with age.

NORTHERN CORN ROOTWORM LARVAL CONTROL IN FIELD CORN IN VIRGINIA, 1978. B. C. Kondratieff*and J. E. Roberts, Sr., Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

The test was conducted in Montgomery Co., Va., from Jun - Jul '78. Three rates of San 326 (5G) and San 6626 (5G) were compared to Furadan 10G and an untreated control. San 326 and San 6626 are code name products of Sandoz, Inc. Test plots measured 75 feet and consisted of 4 rows in the planted field. Treatments were replicated four times in a random-ized complete block design. Furadan was applied in the furrow, in a 7-inch back at planting time. San 326 and San 6626 were applied two days later in a band over the row and lightly incorporated into the soil. Larval damage was assessed on Jul 26 by digging and washing 10 root systems from each replication. Root systems were evaluated using a standard 1-6 rating where 1=little or no damage and 6=3 or more nodes of roots destroyed.

There was no significant difference between treatments at the 0.05 level of significance using the Duncan Multiple Range Test. In the course of evaluation average ECB damage was recorded.

CORN ROOTWORM CONTROL ON FIELD CORN IN VIRGINIA, 1979. B. C. Kondratieff* and J. E. Roberts, Sr., Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Corn was planted (May 10'79) in Montgomery Co., Va., to evaluate planting time applications of eight granular insec-ticides for the control of corn rootworm larva. Treatments were applied in a 7-inch band over the row in front of the presswheel. The experiment was arranged in a randomized complete block design with four replications. Plots for each treatment consisted of four rows 50 feet long on 36-inch centers. Root damage was determined by digging and washing 6 plants on Jul 11'79 from each row. Treatments were evalu-ated by root damage ratings (Iowa 1-6 system). Data was analyzed using Duncan's Multiple Range Test. The soil type was silt loam. The field had a history of Furadan use. Rain-fall for May, June and July was above normal. Air tempera-ture for the period was below normal.

Few northern or southern corn rootworm adults were observed in the field. No significant differences were observed between treatments. No phytotoxicity was evident.

BLACK CUTWORM CONTROL IN NO-TILL FIELD CORN IN VIRGINIA, 1979. B. C. Kondratieff*and J. E. Roberts, Sr., Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Lorsban 4E^R, Orthene 75S^R and Penncap M^R 2 FM were applied using techniques that simulate present equipment methods for control of black cutworm. Corn was planted in small grain stubble on Apr 15'79 in two fields located in Bedford Co., Va. Light weed growth was observed in both fields. Field 1 was planted using 'Pioneer 3147' and field 2 with 'Dekalb 72-B'. The tests (experiments) consisted of plots measuring 14' x by 50' (4 rows) replicated four times in a randomized com-plete block design.

Insecticide treatments were evaluated by counting the number of cut plants per row. Cut plants were removed because some cut seedlings survive and regrow. Both fields had heavy pretreatment black cutworm infestations with cutting pressure averaging 20%.

Cutworm activity was significantly reduced compared with untreated areas, however, none of the treatments provided 100% control. Orthene 75S and Lorsban 4E gave the best con-sistent control of black cutworm larvae. No chemical phyto-toxicity was observed.

FALL ARMYWORM CONTROL ON FIELD CORN IN VIRGINIA, 1979. B. C. Kondratieff* and J. E. Roberts, Sr., Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Eight insecticides were compared for effectiveness in con-trol of fall armyworm. Field corn was planted June 22'79 in Goochland Co., Va. Treatments were arranged in a randomized complete block design with four replicates. Four row plots measured 50 feet by 12 feet in which the two center rows were used for analysis. All insecticides were applied using a 4-gallon hand held sprayer operating at 40 psi and a rate of 20 gallons per acre. Granular materials were applied in a 7-inch band over the whorl. Treatments were applied July 26 and insect counts made 1 and 3 days post-treatment. Numbers of small (instars 1-3) and large (instars 4-6) larvae per plant were determined on each sampling date. Larvae were selected at random and sacrificed to ensure proper counting of larvae. Data was analyzed using Duncan's Multiple Range Test. Soil association was Conagree-Chewada. The field had a history of Furadan use.

The fall armyworm infestation was high (100%) in this field with 1st and 5th instar larvae present when insecticides were applied. Lannate and the three Larvin 500 rates gave good control. All other materials gave intermediate to poor con-trol. None of the materials were phytotoxic.

CONTROL OF THE POTATO LEAFHOPPER IN VIRGINIA, 1979. B. C. Kondratieff* and J. E. Roberts, Sr., Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

At the VPI & SU Animal Science Farm in Montgomery Co., Va. three rates of Orthene 75S and 1 rate of Sevin 80% WP were applied to plots tested for control of the potato leafhopper on a four year old planting of alfalfa in the "second-cutting" growth stage (approximately 16 inches tall, 5% bloom). Plots 20 ft. long by 20 ft. wide, were arranged in a randomized complete block design, and replicated four times. Insecticides were applied with a hand-carried four gallon compressed air sprayer calibrated to apply 108 gallons of water per acre at 50 psi. Pretreatment and post-treatment insect counts were taken using a 15-inch diameter sweep net making 10 pendular sweeps per plot. Post-treatment insect counts were taken 3 and 5 days after treatment.

The alfalfa did not exhibit any phytotoxic effects after treatment. All three rates of Orthene 75S and Sevin 80WP were effective against the potato leafhopper with only light hopper burn being observed at the study site.

TRUE ARMYWORM CONTROL ON FIELD CORN IN VIRGINIA, 1979. B. C. Kondratieff* and J. E. Roberts, Sr., Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Five insecticides were applied and evaluated for control of armyworm in Augusta Co., Va. Funks 5757 variety corn was planted May 1'79 using a randomized complete block design. Four row plots, 50 feet in length were replicated four times. Pretreatment population counts (number of plants with larvae) were obtained representing 200 feet of row replicated twice. Pretreatment population counts indicated 100% infestation. The two center rows of each plot were used for evaluating treatments. Treatments were applied May 30 using a compressed air sprayer operating at 30 psi spraying 73 gallons per acre and a hand cranked duster to apply granular materials in a 6-inch band. Post-treatment counts were obtained on June 1 and June 3 by counting the number of larvae alive or dead per plot. Armyworm larvae were in their second to fourth instar.

Data indicated that the treatments were all significantly different from the untreated check at the 0.05 level of significance using dead larvae as criteria. Lannate (.45 lbs ai/acre) was the most effective of the five insecticides evaluated. The other materials listed in order of effectiveness are Dyfonate 20G (3.75 lbs/A), Dyfonate 20G (5 lbs/A), Penncap M (1 lb ai/A) and Penncap M (0.5 lbs ai/acre).

OATS IN STARTER DIETS FOR WEANED PIGS. E. T. Kornegay and K. L. Bryant, Dept. of Animal Science, VPI & SU, Blacksburg, VA 24061

Four trials, using 138 weaned pigs initially weighing 5.4 kg, were conducted to compare the performance of pigs fed a basal starter diet containing zero or 10% ground whole oats. Average final weight of pigs was 18.2 kilograms. Pigs were housed in environmentally controlled triple deck nurseries. A 22% corn-soybean meal diet with 10% dried whole whey was ad libitum fed until average pen weight was 7 kg; then a 20% protein diet was fed to 11 kg; an 18% protein diet without the whey was fed for the remainder of the test.

Daily gain, daily feed intake and feed per gain were not different between pigs fed starter diets with zero or 10% oats during any weekly period and over the entire trial. Fecal firmness and cleanliness scores were not different between pigs fed diets with and without oats. Diarrhea was not a problem in these studies and no deaths occurred.

Daily gain was similar for pigs housed on all decks; however, contrary to previous reports, feed intake and feed per gain was slightly higher for pigs housed on the bottom deck compared to pigs housed on the top and middle decks. Cleanliness scores indicated that the pigs housed on the lower decks became more soiled as the study progressed.

The addition of 10% ground oats to a corn-soybean meal starter diet did not alter feedlot performance. Diarrhea was not a problem and no deaths occurred.

A SURVEY OF VIRGINIA PEACH ORCHARDS FOR PEACH STEM PITTING AND ASSOCIATED NEMATODES. T. K. Kroll* and J. A. Fox*, Dept. of Plant Pathology and Physiology, VPI & SU, Blacksburg, VA.

Two to five problem orchards/county in 10 Virginia peach growing counties were surveyed between August 1978-June 1979 to assess the incidence and severity of Prunus Stem Pitting (PSP). The age of diseased trees, origin of planting stock, orchard locale, and presence of other diseases and PSP virus weed hosts were recorded. Soil was sampled from PSP diseased trees, trees with other diseases, and healthy trees and assayed for nematodes using the sugar flotation-centrifugation extraction technique. PSP was found in 8 of 10 counties and in 29% of the orchards. The incidence of diseased or dead trees ranged from 1-12%. Although no correlation between PSP and tree age, origin of planting stock, orchard locale, or other diseases was found, PSP was often associated with stress factors such as winter injury, borer damage, mechanical injury, drought, or weed problems. The nematode vector Xiphinema americanum was present in 94% of the samples and several PSP virus weed hosts were present in all orchards. Xiphinema americanum and Helicotylenchus sp. populations were significantly higher near PSP diseased trees than healthy trees. In summary, it appears that: (1) PSP is a widespread problem in VA peach orchards, (2) the nematode vector and weed hosts of the virus are not limiting factors to disease spread, and (3) PSP is often associated with various stress factors including high Xiphinema americanum and Helicotylenchus sp. populations.

EFFECTS OF RALGRO IMPLANTS ON GROWTH RATE AND CARCASS CHARACTERISTICS IN BEEF CATTLE. W. O. Lamm, R. F. Kelly and J. P. Fontenot. Depts. of Animal and Food Science, Virginia Polytechnic Institue, Blacksburg, VA 24061.

In trial 1, steer and heifer calves were implanted at birth with 0, 12, 24 or 36 mg zeranol. Implanted calves were reimplanted with 36 mg at approximately 100 days of age. Daily gain from birth to weaning was similar for implanted calves compared to control calves. In trial 2, bull and heifer calves were implanted at birth or 100 days of age with 0 or 36 mg zeranol. Implanted calves were reimplanted with 36 mg every 100 days until a minimum of 65 days prior to slaughter. Adjusted weaning weights tended to be higher for implanted heifers compared to unimplanted heifers while bulls implanted at birth weighed less than unimplanted bulls or those implanted at 100 days of age. In the growing-finishing phase, unimplanted bulls gained faster (P<.05) than implanted bulls. Heifers gained similarly regardless of implant treatment. Heifers implanted first at 100 days of age had more desirable yield grades than heifers receiving the other treatments. In trial 3, bull and heifer calves were implanted at birth with 0 or 36 mg zeranol. Implanted calves were reimplanted with 36 mg every 100 days until a minimum of 65 days prior to slaughter. Implanted heifers weighed more (P<.01) while implanted bulls weighed the same as unimplanted heifers and bulls, respectively, at weaning. During the growing-finishing phase, implanted bulls and heifers gained faster (P<.10) than their unimplanted counterparts. Carcasses of implanted calves had more desirable cutability than unimplanted calves.

A QUICK AND EASY METHOD FOR ESTIMATING VOLUME IN LOBLOLLY PINE PLANTATIONS. R. C. Lemin*, and D. M. Hyink*. Dept. of Forestry, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

For forest stands in which the variability in height of individual trees is small, it is shown that the consequences of horizontal point sampling in combination with a special type of constant form factor tree volume equation result in estimates of stand volume requiring only an enumeration of the sample trees. Two illustrations of this "ametric" (without measure) technique are given for plantation grown loblolly pine. In the first, cubic foot volume is estimated from stem count, site index and stand age. A second alternative relies upon stem count and mean stand height.

THE EFFICACY OF KABAT® FOR CONTROL OF THE CIGARETTE BEETLE UNDER SEVERE INFESTATION CONDITIONS. J. S. Long; R. M. Lehman;* M. H. Tickle;* and M. A. Manzelli. Philip Morris Research Center, Richmond, VA 23261

KABAT®, also known as ALTOSID®, was evaluated for control of the cigarette beetle under conditions of severe infestation. A total of ten thousand adult cigarette beetles were placed into each of eight hogsheads, located in a miniwarehouse, during May to September, 1978. In early August, 1979, counts were made of the number of adults trapped in each of the hogsheads. Over 12,000 adults were trapped in two control hogsheads (one strip, and one stem) and only six adults in the six hogsheads (three strip and three stem) treated with KABAT®. The KABAT® treatment was successful in preventing larvae of the cigarette beetle from completing their life cycle and continuing to reinfest the commodity.

EFFECT OF BREED COMPOSITION ON YEARLING WEIGHT OF BEEF STEERS. Thomas J. Marlowe and Elizabeth T. Barnes. Dept. of Animal Science, VPI&SU, Blacksburg, Va. 24061

Steer data from a cooperative cattle breeding project with the VA Dept. of Corrections for 1970-75 calf crops at Southampton Correctional Farm (SHCF) and 1972-75 crops at State Farm (SF) were analyzed by L.S. procedures to determine sire breed effect on performance. Sources of V included year, breed, yr x br, dam's age and animal age, plus mgt and yr x mgt in SHCF data. Measurement traits (MT) included ADG and WDA from Wn to 12 and 18 mos, and wt, grade and cond at both ages for 233 and 213 steers at SHCF and 512 and 336 steers at SF at 12 and 18 mos, respectively. All sources acct for signif V in all MT, except age of dam on ADG at 12 mo and ADG, WDA and wt at 18 mo at SF and grade and cond at SHCF.

All crossbreds (XB) outgrew straightbred (SB) controls at both locations. At SHCF, Angus (AA) steers grew about 1/4 lb/day slower than Hol x Ang or Char x Ang steers and weighed 54 and 82 lb less at 12 mo and 89 and 117 less at 18 mo. Diff between XB types was 28 lb at both ages in favor of Char x Angus steers.

At SF all XB steers outgrew the SB Hereford controls by an ave of 36%. Ave wt of XB's at 12 and 18 mo was 56 lb (14.8%) and 71 lb (12.7%) heavier, respectively, than SB controls. Diff in best XB and SB controls was 131 lb (23.4%). Rank of XB's (H to L) by sire breed based on 18 mo wt was Holstein (690), Shorthorn (660), Simmental (640), Charolais (622), Angus and B. Swiss (tied, 584) and Hereford (559).

A MATHEMATICAL MODEL OF A BATCH-TYPE CROP DRYER. F.F. Massie*, D.H. Vaughan, and A.J. Lambert*. Dept. of Agricultural Engineering, VPI & SU, Blacksburg, Va. 24061.

Recent price increases and shortages of fossil fuels have caused farmers to become more aware of the energy used in crop processing. On-farm processing often wastes large amounts of energy due to overdrying and inefficient drying. One possible method of increasing drying efficiency is the partial recirculation of drying air.

Recirculation of the drying air has good potential in peanut drying because water removal is only a part of the curing process. The water must be removed from the crop at a relatively slow rate to maintain good milling quality and flavor. Yet, it must be fast enough to prevent mold formation. Recirculated drying air should have a higher relative humidity than daytime solar heated air. In typical batch drying processes recirculated air should help prevent overdrying where the air enters the peanuts. To establish the best air recirculation procedures, a mathematical model is needed to predict the state of the drying air.

In developing a model, the interior of a drying shed can be considered a partially controlled volume. The psychrometric state of the air at any time inside the controlled volume can be predicted if the initial state is known, the heat additions and losses are known, and the moisture additions and losses are known. Once the state of the controlled volume air is known, the drying potential of the drying air can be estimated.

FEEDING TESTS OF CEUTORHYNCHUS TRIMACULATUS, A POTENTIAL BIOLOGICAL CONTROL AGENT OF THISTLES. T. J. McAvoy* and L. T. Kok. Dept. of Entomology, VPI & SU, Blacksburg, VA 24061

Ceutorhynchus trimaculatus F. is a thistle-rosette feeding weevil found in the Caucasus, mediterranean region and in parts of Central Europe. Its known hosts are thistles of the subtribe Carduinae. It was imported from Italy under quarantine for host specificity testing in Blacksburg, Virginia in 1976. As a potential biological control agent of Carduus thistles, it is necessary to determine whether it poses a threat to desirable or economic plants in the U.S.A. Feeding tests showed that it was able to complete development from the first instar to the adult stage on only 3 out of 27 host plants tested: Carduus nutans L. (musk thistle), C. acanthoides L. (plumeless thistle) and Cirsium vulgare (Savi) Tenore (bull thistle). A fourth plant, Cynara scolymus L. (artichoke) yielded one adult out of 225 first instars and was poorly suited to larval development. Musk, plumeless and bull thistle, Silybum marianum (L.) Gaertn (milk thistle), Cirsium arvense (Canada thistle), Cirsium discolor (two-colored thistle) and artichoke supported oogenesis but Carthamus tinctorius L. (safflower) did not. Oviposition rate dropped sharply when adults were switched from musk thistle to artichoke. Significantly more eggs were laid on the thistles than on artichoke. Results of the tests indicate that C. trimaculatus is sufficiently host specific on the target weeds.

PRELIMINARY EVALUATION OF A PRACTICAL SAMPLING METHOD FOR ESTIMATING ORIUS INSIDIOSUS (SAY) POPULATIONS ON APPLE TREES. J. P. McCaffrey, M. P. Parrella, and R. L. Horsburgh. Dept. of Entomology, VPI & SU, Shenandoah Valley Res. Sta., Steeles Tavern, VA 24476.

The anthocorid bug, Orius insidiosus is an important polyphagous predator in Virginia apple orchards. The most frequently used method of sampling O. insidiosus populations is tapping limbs over a cloth covered tray. The dislodged bugs are then counted. While efficient, this sampling technique is time consuming and damaging to tree limbs and fruit. The purpose of this study was to investigate the potential for relating, by regression, population estimates obtained from a simpler, less-damaging, but less efficient, visual timed search to the population estimates obtained by limb-tapping.

Our results indicate that population estimates obtained by a visual search are related to those obtained by limb-beating. Also, the results indicate that further studies should be directed towards evaluating the sampling method for each development stage (i.e., nymph vs. adult) of the bug.

SEASONAL ABUNDANCE AND SPECIES COMPOSITION OF APHIDS IN SMALL GRAINS. R. M. McPherson and J. R. Martin*. Dept. of Entomology, Va. Polytechnic Inst. and State University, Blacksburg, Va. 24061

Fluctuations in population densities of the aphid complex in small grain were directly related to weather conditions during the 1978-79 and 1979-80 seasons. Populations rapidly increased in wheat, barley, and rye during Nov.-Dec., exceeding 200 aphids/row foot. However, densities steadily declined during Jan.-Feb., when daily mean temperatures were commonly mid-30's (°F) and below. Over-night temperatures below 32 °F followed by mid-day temperatures of 50-60 °F had little effect on reducing aphid populations.

Greenbugs (GB) and corn leaf aphids (CL) were the predominate species during Nov.-Dec. In Jan., GB, CL and oat bird-cherry aphids were present in equal numbers. CL aphids rapidly declined during Feb.-March and were not in small grain in April. English grain aphids (EG) comprised only a small percentage of the complex during Nov.-Feb.; however, during March and April EG and GB were the most abundant species.

DIMENSIONS OF CYSTS AND EGGS OF FOUR ISOLATES OF HETERODERA SCHACHTII. L. I. Miller and Lorraine S. Graney. Dept. of Plant Path. & Physiol., Va. Polytech. Inst. & State Univ., Blacksburg, VA 24061.

A comparison was made of the dimensions of cysts and eggs of field isolates of Heterodera schachtii from New York (N) and Florida (F) with cabbage as the host plant and from California (C) and Michigan (M) with sugar beet as the host plant. Measurements (in μm) of 40-90 cysts of the four isolates were as follows. Length including neck:N 565 - 1010 (mean 812.0, standard deviation ± 97.0) F 673 - 1140 (897.0 ± 90.0), C 664 - 942 (797.0 ± 65.4), M 408 - 991 (716.5 ± 109.9). Breadth:N 401 - 652 (508.1 ± 81.9), F 370 - 594 (480.6 ± 51.2), C 403 - 650 (516.4 ± 55.4), M 251 - 650 (449.8 ± 91.4). Length/breadth ratio:N 1.2 - 1.9 (1.6 ± 0.2), F 1.5 - 2.3 (1.9 ± 0.2), C 1.2 - 2.2 (1.6 ± 0.2), M 0.7 - 2.4 (1.6 ± 0.2). Measurements of 40 eggs with second-stage larvae of the isolates were as follows. Length:N 100 - 109 (105.3 ± 2.6), F 95 - 108 (100.4 ± 4.0), C 103 - 116 (108.1 ± 3.7), M 95 - 118 (105.9 ± 5.6). Breadth:N 43 - 49 (46.6 ± 2.2), F 40 - 50 (46.3 ± 2.2), C 38 - 55 (43.6 ± 3.7), M 43 - 58 (48.5 ± 3.6). Dimensions measured of the four isolates overlap and they overlap with published measurements of H. glycines.

THE IMPACT OF VEGETABLE GARDENING ON DIETARY INTAKES OF THE ELDERLY PEOPLE IN SOUTHSIDE VIRGINIA. S.W. Moak. Dept. of Human Ecology, Va. State Univ., Petersburg, Va. 23803

Vegetables are grown by a significant number of elderly people, and it is becoming a popular hobby. Comparative studies indicate that the number of suburban and rural vegetable gardeners were significantly higher (p<.01) than nongardeners. However, in urban setting, nongardeners were significantly greater than gardeners (p<.01). Mean energy and nutrient intakes by gardeners were generally higher than nongardeners. However, vitamin B_6, vitamin C, and iron intakes were only nutrients which were significantly different at the level of p<.05. Food consumption pattern of elderly gardeners showed that tomato consumption was significant at the level of p<.01. Green beans and potato consumptions were significantly different between the gardeners and nongardeners at p<.05. The gardeners consumed more varieties of the vegetables. The home grown vegetables were preserved by 70 percent of the elderly gardeners. Approximately, 25 percent of the gardeners supplemented 30 percent of their family need of vegetables. In terms of food expenditure, gardeners spent 15 percent less than the nongardeners per person per month.

EFFECT OF SEED SIZE ON THE YIELD, GRADE AND VALUE OF NC 7 PEANUT CULTIVAR. R. Walton Mozingo. Tidewater Res. and Cont. Ed. Ctr., Suffolk, Va. 23437.

Sizing peanut seed is a normal practice in the Southeast and Southwest peanut production area where Spanish and Runner type peanuts are grown. However, this has not been the normal procedure in the Virginia-Carolina production area where the large seeded Virginia type peanuts are produced. With the release of the Virginia type NC 7 cultivar, which has a high percentage of extra large kernels, seed-size warranted investigation. In this experiment the effect of six seed-sizes on yield, grade and value of the NC 7 cultivar was determined.

The peanut seed were sized as follows: all size kernels > 16/64", > 16/64" < 24/64", > 16/64" < 26/64", > 16/64" < 28/64", > 24/64" and > 26/64" x 1 inch slotted screen. Seed size did not affect percent fancy pods, percent total meat, yield or value per acre significantly. There was a trend toward production of a higher percentage of extra large kernels where the larger seed were planted. Seed harvested from this experiment will be sized and further tested.

VARIABILITY OF A WET SOIL MAPPING UNIT IN GREENSVILLE COUNTY, VIRGINIA. C.D. Peacock, Jr., W.J. Edmonds, and J.C. Baker*. Department of Agronomy, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

A complex of Aquults and Aquepts had been mapped throughout the county, based on use and management and classification. Series names were needed to identify the complex for correlation. A random selection method was used to identify taxonomic units and establish their percentages. The study was stratified between two terraces. Strata 1 was below an elevation of 100 feet and Strata 2 was above 100 feet.

Strata 1 was very uniform with all members in the clayey, mixed, thermic family placement. Strata 1 was represented by 50 percent Aeric Ochraquults, 33 percent Aquic Hapludults and 17 percent Typic Ochraquults. This complex is recommended to be named Wahee Variant-Craven Variant soils.

Strata 2 was not uniform. All members were placed in the siliceous, thermic family placement. Strata 2 was represented by 33 percent coarse-loamy Aeric Ochraquults, 17 percent coarse-loamy Typic Ochraquults, 17 percent coarse-loamy Aeric Fragiaquepts, 17 percent fine-loamy Typic Ochraquults, and 16 percent Typic Psammaquents. The complex cannot be named at present since 50 percent of the unit has no established series.

Separate mapping units will be used for each strata or terrace.

SOIL CHEMICAL VARIATIONS IN TWO DRAINAGE CATENAS IN GREENSVILLE COUNTY, VIRGINIA. C.D. Peacock, Jr., W.J. Edmonds, and J.C. Baker*. Department of Agronomy, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

Two drainage catenas were selected from soils with similar marine and fluviomarine sediments to determine if relationships in pH, calcium, and the aluminum-total acidity ratio from well drained to poorly drained soils existed. Chemistry from the Soil Survey lab at Virginia Tech using 1N KCl and BaCl$_2$-TEA extraction was used for the selected soils.

In both catenas, the aluminum-total acidity ratio increased from a well drained soil to a poorly drained soil and also increased with increasing depth in most soils. The mean of the ratio was greater than 30 percent in all but one observation. The pH was below 5.5 in all observations and below 5.0 in most observations. Calcium decreased with depth. As the calcium decreased with depth, the aluminum-total acidity ratio increased with depth.

This study reflects a strong potential for aluminum toxicity to some plants and crops.

THE INFLUENCE OF PREPLANT SOIL INCORPORATED TRIFLURALIN AND PEBULATE ON REPRODUCTION OF GLOBODERA SOLANACEARUM ON TOMATO. C. L. Pirkey* and L. I. Miller. Dept. of Plant Pathol. & Physiol., Va. Polytech. Inst. & State Univ., Blacksburg, VA 24061.

The influence of preplant soil incorporated herbicides, trifluralin (TF) and pebulate (PB) on reproduction of the cyst nematode, Globodera solanacearum (GS) on 'Pearson A-1' tomato, was studied in the greenhouse in Virginia. The treatments included GS + TF, GS + PB, GS, and Control (no GS, PB, or TF). One hundred cysts of GS containing about 160 eggs/cyst were introduced into a cyst-free soil in 15.2 cm pots containing a 2:1 mixture of expanded shale (Weblite®) - Groseclose silt loam. TF at 0.5 ppm or PB at 1.5 ppm was incorporated in the nematode infested soil. Three days after the herbicide treatments were applied, a single 2 month-old tomato seedling was transplanted to each pot of all the treatments and grown at a temperature of 23-27°C. After 3 months the soil was screened for nematode females. The number of females produced was 12 percent greater in the GS + TF treatment and 27 percent greater in the GS + PB treatment than in the GS treatment. Vine growth, as measured by dry weight, was inversely related to the number of females formed on the tomato roots. The reasons for the greater reproduction of the nematode in the herbicide treated soils is currently not known.

HYPOPIAL FORMATION   IN CALOGLYPHUS BOHARTI (ACARINA: ACARIDAE). S. L. Poe and E. A. Cross*. Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Experiments were performed to test the influence of environmental factors on formation of the facultative deutonymph (hypopode) of Caloglyphus boharti (Cross). Mites were reared at different humidities, with and without food, under crowded conditions, and in dishes with mite excretory products at 64°F, 74°F, and 84°F, to test for hypopial formation.

Food shortage is a major factor influencing hypopial formation, but the role of the other factors was not conclusively demonstrated.

THE AGRICULTURAL ECOLOGY OF INTERCROPPING. M.K. Reynolds* and R. W. Elias. Dept. of Biology, Va. Polytechnic Inst. and State Univ., Blacksburg, Virginia, 24061.

Agriculture and ecology have developed as two polarized sciences: one applied, the other theoretical. Both converge in the study of agroecosystems. The growing concern for world food supplies has focused attention on one such system: intercropping.

One important reason that intercrops may be successful is the intensive use of environmental resources. Different canopy levels can absorb more solar energy and CO_2, while differences in root architecture or nutrient needs can increase the use of soil resources. Other positive interactions include N_2 fixation by legumes, and decreased insect damage or weed infestation.

This study investigates the energy budgets of a maize-soybean intercrop system. Maize yields increased while soybean yields decreased, resulting in a land equivalent ratio (LER) of one. The most closely intercropped soybeans had increased leaf biomass, but decreased grain biomass. Intercropped maize had greater solar conversion efficiency earlier in the season than monocropped maize. Both effects can be explained by the amount of solar radiation intercepted.

SORGHUM RESPONSE TO PHOSPHORUS AND POTASSIUM APPLICATION ON A DAVIDSON SOIL. R. B. Reneau, Jr.* and G. D. Jones. Department of Agronomy, VPI & SU, Blacksburg, Virginia 24061 and Piedmont Research Station, VPI & SU, Orange, Virginia 22960.

Application of phosphorus (P) and potassium (K) are both essential for maximum production of crops. This study was conducted to determine the effect of P and K on the yield of forage sorghum (Sorghum sudanese) on a Davidson (Rhodic Paleudult, clayey, kaolinitic, thermic) clay loam soil. Two experiments were conducted during 1978 and 1979. One where P was applied at rates of 0, 14.7, 29.3, and 58.7 kg/ha and was split with K applications of 0 and 112 kg/ha the other where K rates of 0, 27.8, 55.8 and 112 kg/ha were the subplots and P applications of 0 and 58.7 kg/ha were the main plots. When two rates of K were applied over four rates of P yields were significantly increased with increased P application for both 1978 (from 20.5 to 31.6 metric tons/ha) and 1979 (from 15.2 to 20.7 metric tons/ha). There was a significant response to K application in 1979 (from 17.2 to 19.5 metric tons/ha) while in 1978 a year of more optimum moisture conditions no response to K application was observed. When no P was applied at each level of K, there was a decrease in yield with increased K application. The chemical composition of the plant tissue generally increased in P and Mg with increased P application. The application of K increased K concentrations, but reduced Ca and Mg concentrations as a result of ion competition.

CORN COBS VERSUS CORN STALKS: A COMPARISON OF ENERGY VALUES FOR DRYING CORN. J.K. Riggins*, A.J. Lambert*, and D.H. Vaughan. Dept. of Agricultural Engineering, VPI & SU, Blacksburg, Va. 24061.

Corn residue samples were tested as potential fuel sources for drying corn. Samples were taken during August and September, 1979 at TRCEC, Holland, Virginia. Each sample included the entire corn plant five inches above ground level. For each sample, bomb calorimeter tests were performed both on representative cob sections and representative plant sections (excluding kernels). All tests were made on a wet basis and thus reflect variations in energy as a function of moisture content. The combustion results of cob versus the entire plant were compared at different harvested kernel moisture contents to determine the practical use of each fuel, from a combustion standpoint, in drying corn.

Combustion results indicate that cobs and stalks have near identical energy values at the same moisture content and for the same weight of dry matter. However, unlike stalk energy, cob energy can be reasonably predicted as a function of kernel moisture content. Kernel moisture content cannot be used to effectively predict stalk energy since wide variations exist between stalk energy values at similar kernel moisture contents.

SWINE, CONTROL OF HOG LICE ON BROOD SOWS, 1978: J. E. Roberts, Sr., and B. C. Kondratieff*, Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va.

Two tests were conducted in Buckingham Co., Va., from June '78 to Aug '78 on brood sows. Two rates of GX-118, 1:2 parts water and 1:5 parts water, were compared to pretreatment counts and untreated check animals. GX-118 contains 11.6% Prolate[R] (phosmet) which equals 1 lb per gallon active ingredient. Both dilutions were applied as a pour-on. Animals were treated along the backline from the neck area to the hip area. Approximately 1 oz/cut of body weight was applied to each animal by means of a calibrated dipper.

Excellent control was obtained for a period of three weeks, using both rates. There was no evidence of adverse effects on the animals or the applicator.

SWINE, SARCOPTIC MANGE CONTROL, 1979. J. E. Roberts, Sr., and B. C. Kondratieff*, Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Testing was conducted in Cumberland Co., Va., during the period of Mar '79 thru June '79. Experiments evaluated Kemolate (GX-118) for control of contagious sarcoptic mange. GX-118 is a code name for an 11.6% phosmet (Prolate) formulation which contains one pound of active ingredient per gallon. A 1:49 dilution was applied to six Yorkshire gilts weighing approximately 150-160 lbs. A four gallon compressed air sprayer operating at approximately 30 psi was used to apply the material. A second test was conducted as a repeat of the original. Approximately 16 ozs. of mixture was applied to each animal spraying thoroughly inside the ears, flanks and pastern areas.

In the original test and the repeat the control obtained from GX-118 was poor to fair at best. No adverse effects on animals or applicators was observed.

SWINE, HOG LOUSE CONTROL WITH ECTIBAN[R], 1979. J. E. Roberts, Sr., and B. C. Kondratieff*, Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Two formulations of Ectiban[R] were applied on July 1'79 to two groups of animals in a confinement barn. Each treatment consisted of 4 animals. Group I was treated manually with Ectiban 0.25% Livestock Dust or at a rate of 1 oz. per animal. Group II was treated with Ectiban 5.7% Emulsifiable Concentrate with an end concentration of 0.025% at a rate of 1 pt. per animal with a pressurized sprayer. Group III was untreated and served as the control. Treatments were applied particularly on the face, ears, neck, dorsal mid-line and approximately the dorsal half of the side. Evaluation was done by counting adult and immature lice and observing eggs.

Both spray and dust formulations were effective initially. However populations built up rapidly after 8 days. A second application at original rates resulted in complete louse control up to 30 days (termination of test). Transient scratching and rubbing was observed for several minutes after spraying and dusting. No other adverse reactions were observed.

CATTLE, FACE AND HORN FLY CONTROL ON BEEF CATTLE WITH ECTRIN[R] EAR TAGS, 1979. J. E. Roberts, Sr., and B. C. Kondratieff*, Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Ectrin[R] ear tags were attached to two herds of beef cattle in June '79. The first group consisted of 44 adult Angus cows with calves. All cows were tagged in both ears on June 20'79. The second group consisted of 34 adult Hereford cows with calves and were tagged in one ear on June 21'79. Calves were not tagged. A third group of similar size, with no fly treatment, served as a control. The groups were separated by at least 2 miles. An assessment of treatment efficacy was made prior to treatment and post-treatment by inspecting 10 head selected at random from each herd at weekly intervals usually between 10-11 a.m. Face flies were counted on the entire face while horn flies were counted on both sides of the entire animal. Binoculars were used to aid counting when necessary. Data was analyzed using Duncan's Multiple Range Test.

Ectrin ear tags were very effective against the horn fly throughout the test period (P<0.01). Face flies were also significantly reduced in number (P<0.01). The loss of three ear tags (one ear tag per animal) occurred with the Angus herd. There was no significant difference between two or one ear tag per ear. No irritation or necrosis was noticed in the ears.

AN ECONOMETRIC MODEL OF THE VIRGINIA BEEF AND PORK INDUSTRIES: CONCEPTUAL AND STATISTICAL PROBLEMS. A. Safyurtlu,* K. H. Baum, and W. Purcell.* Dept. of Agricultural Economics, VPI & SU, Blacksburg, Va., 24060

A modified econometric model of the Virginia beef and pork subsectors has been estimated as part of a larger research effort to model Virginia agriculture. Difficult conceptual problems involving structural specification and linkage with macro models of the U.S. beef and pork sectors with impact and interim multipliers have been considered. Statistical problems arising from incomplete data series compiled by both the state and the SRS, USDA limited both the structural detail incorporated into the model, and the number of estimated variables. The econometric equations included in the model are beef cow inventory, beef cow slaughter, calf inventory, calf slaughter, sows farrowed, market hog inventory and hog slaughter. Exogenous national target variables were specified as barrow and gilt (BGP), veal (VP), and utility cow prices (CUPO). The effects of a 1,250 million pound increase in national beef imports on the Virginia beef-pork economy were analyzed in a two-step procedure: (1) the impact of national policy on target variables (BGP, CUPO, PV), and (2) the initial and multiperiod effect of the target variables on the Virginia beef-pork sector.

INSECT AND MITE PESTS OF AZALEAS AND THEIR RESPONSE TO CONTROL MEASURES. Peter B. Schultz and Liz Ann Parnell. Virginia Truck and Ornamentals Research Station. Virginia Beach, VA 23455.

Azaleas are commonly injured by several insect and mite species. The azalea caterpillar, Datana major, was a major problem of azaleas in residential plantings, being first observed on August 23, 1979. Five insecticides (Bacillus thuringiensis, Sevin, Larvin, and Bendiocarb) were tested and all were effective in controlling the larvae within 48 hours after treatment. The azalea lacebug, Stephanitis pyrioides, is a pest of azaleas both in greenhouses and outdoors. Sevin, Orthene, and the synthetic pyrethroids controlled this insect. The azalea leaf miner, Gracillaria azaleella, and the azalea leaf tier are also found in greenhouses and outdoors. The leaf miner can be controlled by soil and foliar systemic insecticides, while leaf tier control is still being studied. The Japanese weevil is a foliage feeder that inflicted heavy damage in 1978 but was at very low levels in 1979.

The southern red mite, Oligonychus ilicis, remained at low levels in 1979 until late fall. In September, treatments of Kelthane, Plictran, Vendex and Omite were applied to a block of Hershey red azaleas. All treatments eliminated the infestation while the untreated block had a high mite population until the first frost.

EFFECTS OF MYZUS PERSICAE (HOMOPTERA: APHIDIDAE), ON FLUE-CURED TOBACCO YIELD, QUALITY, AND CHEMICAL COMPOSITION. P. J. Semtner. Southern Piedmont Center and Dept. of Entomology, V.P.I. & S.U., Blackstone, Va. 23824

Studies were conducted during 1978 to determine the effects of the green peach aphid, Myzus persicae (Sulzer), on the yield, quality, and chemical composition of flue-cured tobacco, Nicotiana tabacum L.

Aphid populations were adjusted in the different treatments by supplementing natural populations with artifical infestations in some treatments and by using insecticides to reduce them in others. Population estimates were made weekly for comparisons among treatments. Tobacco was harvested and yield, quality, and chemical composition, including total nitrogen, total alkaloids, and reducing sugars were determined.

Compared to the control, which had aphid populations maintained at low levels, tobacco with very high aphid populations had reductions in yield of 14 to 20%, in value/ ha of 16 to 25% and in value/kg of 2 to 8%. Tobacco treated with malathion and then reinfested 5 weeks after transplanting had high aphid populations which resulted in significant reductions in yield and quality, while reinfestations at 6 weeks after transplanting did not significantly reduce tobacco yield or value.

Leaves from the third harvest (mid-stalk leaves) of heavily infested tobacco had significantly lower reducing sugars and higher total alkaloids than the control tobacco.

AN IN VIVO STUDY ON THE EFFECT OF ANCYMIDOL (A GROWTH RETARDANT) ON SOYBEAN INTERNODE ELONGATION. D. G. Shilling* and D. M. Orcutt. Dept. of Plant Pathology and Physiology, Va. Tech., Blacksburg, VA 24061.

Ancymidol and gibberellic acid (GA_3) were applied in hydroponic solutions, in various concentrations and combinations, to 7 day old soybean plants (Glycine max L. Merr.). Growth was determined by measuring internode elongation over a 10 day period. Final fresh and dry weights of stem tissue were also obtained. Plants were maintained in a growth chamber under continuous illumination at 25°C.

Both ancymidol and GA_3 were shown to affect all 3 growth parameters, and these effects were shown to be concentration dependent. Growth was stimulated by GA_3 at all 3 concentrations tested (10^{-6}, 10^{-7} and 10^{-8}M). The degree of stimulation increased concurrently with an increase in concentration. Ancymidol inhibited growth at concentrations of 10^{-7}, 10^{-6} and 10^{-5}M, but at 10^{-9} and 10^{-8}M growth was either unaffected or slightly stimulated. Ancymidol-induced growth inhibition was partially or in some cases totally alleviated by joint applications of GA_3. The addition of GA_3 also delayed the onset of ancymidol-induced inhibition of internode elongation. GA-stimulated growth was enhanced by low concentrations of ancymidol (10^{-9}M), but the interaction was antagonistic when the concentration of ancymidol was increased. The type of ancymidol-GA interaction was therefore dependent on the concentration of the 2 chemicals.

OVERWINTERING MORTALITY OF THE ROSETTE WEEVIL, CEUTHORHYN-CHIDIUS HORRIDUS. P. J. Sieburth* and L. T. Kok. Dept. of Entomology, VPI & SU, Blacksburg, VA 24061

Ceuthorhynchidius horridus (Panzer), a thistle rosette weevil imported from Europe for the biological control of musk thistle (Carduus nutans) and plumeless thistle (Carduus acanthoides), was tested for host specificity before it was released in Virginia in 1974. Various aspects of this weevil have been studied to find out more about its attributes and its ability to adapt to its new environment. Included are studies to ascertain how well it overwinters in southwest Virginia and to determine if overwintering is an important mortality factor. Overwintering adult weevils were placed in specially constructed field cages between November and April.

Cages (3' x 3' x 3') consisted of a wooden frame, plywood bottom, fine wire mesh on four sides and organza on the door. Soil was placed in the cages to a depth of 15cm; three musk thistle rosettes were planted in each cage during the summer. In November 6 female and 7 male weevils were added to each of 10 cages, before they were sealed shut. Weekly high and low temperatures, snowfalls and unusual weather were recorded. In April, when adult activity (feeding and mating) was observed, the cages were brought into the laboratory for counts of surviving adults. Survival rate ranged from 38.5-76.9%; no significant differences in mortality were observed between sexes.

WATER QUALITY EFFECTS OF AGRICULTURAL LAND USE. M. D. Smolen*. Dept. of Ag. Engr., Va. Polytechnic Inst., Blacksburg, Va. 24061.

Three adjacent watersheds (20 to 50 ha) in the southeastern Piedmont section of Virginia were monitored for four years to determine the water quality effects of cropping activity. Through the period of study, one of the three watersheds was maintained as a control, with no cropping activity and no chemical applications. The background condition as represented by the control watershed has extremely low inorganic nitrogen concentration (flow-weighted mean 0.026 mg/l) and has total phosphorus concentration (.059 mg/l) slightly in excess of the proposed EPA criterion level. Inorganic nitrogen concentration observed in the treated watershed ranged five to seven times higher than the control. Total nitrogen export from the treated watersheds was observed to be twice as high as the control. Total phosphorus export from the treated watersheds was three to five times higher than the control. Ammonium and nitrate nitrogen input from rainfall was less than total nitrogen export from the treated watersheds, but slightly greater than total nitrogen export from the control. A mass balance calculation indicated that 10 to 14 percent of the fertilizer nitrogen used in the treated watersheds was exported in stream flow. The corresponding estimate for phosphorus indicated that two percent of the phosphorus from fertilizer was exported.

PRODUCTION AND UTILIZATION TRENDS IN THE VIRGINIA APPLE INDUSTRY. F.J. Spinelli* and H.S. Baumes, Jr. Dept. of Agricultural Economics, Va. Polytechnic Inst., Blacksburg, Va., 24061

The Virginia apple industry has undergone several changes over the past 40 years and is expected to continue changing in the future. This paper examines certain elements that affect production and marketing of Virginia's apple crop. A trend analysis is presented with projections to the year 2000.

Some factors examined in this paper are orchard size, numbers of orchards, location of orchards, tree density, production by variety, and utilization. It was found that orchard size is increasing and total orchard numbers declining. There will be an estimated decline of 200 growers in Virginia by the year 2000. Production from the remaining 400 orchards is expected to be primarily marketed in the processing sector. Since 1950 the percentage of the Virginia apple crop being processed has grown from 50 percent to 72 percent in 1979. If the trend continues, by the year 2000 over 90 percent of the apple crop will be processed.

SOUTHERN CORN ROOTWORM CONTROL ON PEANUTS IN SOUTHEASTERN VIRGINIA. John C. Smith, VPI&SU, TRACEC, Suffolk, VA 23437

Experiments were conducted in 1978 and 1979 at two sites in order to develop a data base for establishing a pest management program. Dyfonate®10G @ 2.0 lb AI/acre when applied on 7/31/78 controlled the southern corn rootworm and allowed 3.3% injured peanut pods. The same chemical and rate applied on 9/1/78 allowed 19.6% injured pods. Injury in untreated controls averaged 38.7%. Values derived from grades and yields showed significant differences between treated and untreated plots. Application of Dyfonate on 8/1/79 and 8/14/79 allowed 2.4% and 9.9% injured pods, respectively. Differences in value were again significantly better than controls.

Chemical controls applied on the basis of percent injured pods, as determined by weekly survey, demonstrated no significant difference in injury or value due to treatment. Numerical differences favored treatment at the 1% level (8/16/79) followed numerically by applications at 3% and 5% on 8/29/79 and 9/3/79, respectively.

Insecticidal applications to a rootworm resistant variety (NC 6) allowed greater injury in plots treated with ineffective chemicals than in untreated plots. Dyfonate treatments were effective at 1/4, 1/2 and full rates of application.

A FORESTRY DATA BASE FOR HARVESTING CHARACTERISTICS. G. L. Somers* and R. G. Oderwald*. Dept. of Forestry, VPI&SU, Blacksburg, Va. 24061

A forestry data base is being developed to test the feasibility of bringing together information now available from the Federal Government, various state agencies, trade associations, and individual companies, and putting that information into a common, easily referenced form. The information needs of forestry equipment companies and land managing firms were identified through questionnaires, letters, comments, and conversations. Generally, the information desired concerned land form, trafficability, forest type, stocking and growth, ownership, and potential work force. The MARK IV data base management program was chosen as the central software for the project. Information is stored in the program in a layered fashion. Large scale information such as county identification, major timber types, and Forest Survey information stored on a large grid of points, with more specific information stored on a finer grid. Presently county and stocking have been stored on a 10 by 10 km grid and elevation, slope, and aspect on a 1 by 1 km grid. Information on soils, ownership, growth, and demographies is being collected to add to the data base at various levels. The base of each grid point at any level is the Universal Transverse Mercator coordinates of the point taken from a Defense Mapping Agency digital terrain tape which provides elevations and UTM coordinates for points on a 208 foot grid. Slope and aspect were also computed from these elevations.

SOURCES OF AGRICULTURAL GROWTH IN VIRGINIA. E. Lee Sprouse*, J. D. Coffey*. Department of Agricultural Economics, Virginia Polytechnic Institute and State Univ., Blacksburg, Va. 24061.

The purpose of this study was to highlight the major changes in Virginia agricultural production over a period of twenty-five years (1949-1977.) Special attention was given to the impact of changes in conventional inputs such as land, labor, and capital, and to determine the effect of new and improved technology attributable to research and extension expenditures.

These input factors were evaluated to measure the contribution of research and extension programs to agricultural production in the state for prediction purposes to determine future allocations to these programs.

HEAT RECOVERY FROM VENTILATION EXHAUST OF LIVESTOCK BUILD-
INGS. L.A. Stauffer*, D.H. Vaughan, and N.E. Blackwell*.
Dept. of Agricultural Engineering, VPI & SU, Blacksburg, Va.
24061.

A heat pipe heat exchanger was installed with a ventil-
ation system in a swine nursery in Blacksburg, Va. The
purpose of the heat exchanger was to preheat incoming air
with the heat extracted from the exhaust air. The ob-
jectives of the research were (1) to evaluate the operating
performance of the heat exchanger, (2) to determine its
economic feasibility, and (3) to determine how dust con-
centrations in the exhaust air would affect its performance
and life.

A heat pipe is a passive device that uses conduction,
convection, vaporization and condensation to absorb and re-
lease the latent heat of a working fluid. This two-phase
system has a thermal conductance a thousand times that of
copper. Since the active working fluid allows for more heat
transfer per unit volume than most other heat exchangers,
a relatively small unit may be used.

The heat pipe heat exchanger had an overall effectiveness
of 0.53 +/- 8% and supplied 45% of the heat requirement for
the swine nursery during 1979 tests. Fouling from dust was
not a significant problem. The payback period for the heat
recovery device is less than 5 years. (Aided by USDA grant
11-14-7001-557).

INFLUENCE OF EARLY PLANT DEVELOPMENT AND MANAGEMENT ON
ACRONOMIC PERFORMANCE OF TOBACCO, NICOTIANA TABACUM. T. R.
Terrill and J. L. Jones. VPI & SU Southern Piedmont Center,
Box 448, Blackstone, VA 23824.

Early plant development may have a direct impact on the
agronomic evaluation and economic worth of any crop plant.
Plant development is especially important for tobacco since
the vegetative portions are marketed. Transplant treatments
included initial plant size, normal and low leaf area
(clipped), root condition, and storage variables. Field
experiments were conducted in 1978 and 1979 to measure the
impact of plant quality on growth and final production of
flue-cured tobacco. A randomized complete blocks design was
utilized within years. We found that initial plant size was
a paramount factor which influenced tobacco production.
Storage conditions also influenced plant development with
cold storage superior to tobacco barn storage. Large differ-
ences were recorded for clipped plants during the early and
mid-season periods, but there were no differences associated
with clipping (reduced leaf area at transplanting) after
mid-season. In general, very small plants and those sub-
jected to seven days of storage showed poor growth and total
productivity. The combined analysis of variance revealed
highly significant year by treatment interactions for yield,
value and percent survival. The interactions permit inter-
pretation of the influence of plant quality under adverse
(1978) and favorable (1979) plant establishment conditions.

FLOORING MATERIALS FOR SWINE NURSERY CAGES. H. R. Thomas
and E. T. Kornegay, Tidewater Research and Continuing Educa-
tion Center, VPI & SU, Suffolk, VA 23437

Plastic coated expanded metal (9 gauge, 1.3 x 2.5 cm),
galvanized woven wire (5 gauge, 1.0 x 3.8 cm) and galvanized
flat expanded metal (9 gauge, 1.9 x 3.8 cm) floors were com-
pared in two trials using 288 weaned pigs averaging 7.4 kg.
Average final weight of pigs was 23.4 kg and pigs were on
test an average of 42 days. Pigs were housed in an environ-
mentally controlled triple deck nursery. A 20% protein corn-
soybean meal diet with 10% dried whole whey was ad libitum
fed until the average weight of pigs in a cage was 11 kg; an
18% protein dried without whey was fed afterwards. Daily
gain, daily feed intake and feed efficiency were not differ-
ent (P .10) between pigs housed on the different types of
floors. However, pad scores were lower (P .05) suggesting
fewer cuts, cracks and abrasions, for pigs housed in cages
with plastic coated expanded metal floors as compared to pigs
housed in cages with woven wire and expanded metal floors.
Overall means adjusted for initial weight were respectively
for plastic coated expanded metal, galvanized woven wire and
galvanized expanded metal: daily gain (kg) - .37, .37 and
.36; daily feed intake (kg) - .74, .74 and .72; feed per gain
ratio - 1.97, 1.99 and 1.97. Pigs housed on the bottom,
middle and top decks performed equally well with no apparent
effects on their health and behavior.

A GOAL PROGRAMMING METHOD FOR FOREST LAND APPRAISAL. J.
F. Thurmes*. Biometrics Sect., Dept. Forestry, Va. Poly-
technic Institute, Blacksburg, Va. 24061.

It is difficult to appraise the fair market value of
areas where forestry and agriculture do not compete direc-
tly, as forest land is rarely sold absent of stocking.

This paper presents a goal-programming method of esti-
mating forest land value components from comparable market
sales, and compares it with methods presently in use. The
goal-programming method is a form of non-least squares re-
gression which minimizes the sum of absolute deviations
from the regression. Compared to least-squares regression,
relatively less weight is given to those sales near the
fringes of the data. This is reasonable, as the data on
the fringes can be expected to provide "less valid" indi-
cations of fair market value. The goal programming model
also offers flexibility to the appraiser in the relative
weighting of sales.

The method performed well in an appraisal using data
from Western Oregon. It provided estimates of bare land
value that compare well with other analyses.

SHORT-HORNED GRASSHOPPERS IN SOUTHERN PIEDMONT FORAGE
CROPS. Taylor Williams*. Dept. of Entomology, Va. Polytech-
nic Inst., Blacksburg, Va. 24061

Ecological sampling of grasshoppers (Orthoptera:Acrid-
idae) was performed in ten of Virginia's piedmont counties.
Results from collection in three different forage crops
showed Melanoplus f. femurrubrum (DeGeer) to be the most
important species present, both in terms of density and
distribution. Other frequently encountered species included
Chortophaga viridifasciata (DeGeer), Dichromorpha viridis
(Scudder), Encoptolophus sordidus (Burmeister), Hippiscus
rugosus (Scudder), Melanoplus d. differentialis (Thomas),
and Syrbula admirabilis (Uhler).

SHEAR STRENGTH OF ANIMAL BONE. J.H. Wilson* and J.L. Baker.
Dept. of Agricultural Engineering, Va. Polytechnic Inst.
and State Univ., Blacksburg, Va. 24061.

Many researchers have measured the elastic properties of
bone as a means of evaluating metabolic or endocrine
reactions in animals. These evaluations are incomplete
without knowledge of all the properties of bone. One such
example is the shear properties of bone.

Special fractures indicating torsional (shear) loads
appear in many athletes. Any attempts at fixation, there-
fore, must involve the installation of a fixation unit
capable of surviving torsional (shear) loads. Animals used
for work or pleasure (horses) also experience these same
shear failures. Pure shear tests have been conducted to
evaluate the ultimate shear strength of animal bones.
Results indicate that the shear strength is about one-
tenth of that of flexural strength. Reviews of the
literature indicate that several others have found similar
results for the human.

Analytical work indicates that shear can be a very
important segment of the deflection in bending. If the
length to diameter ratio (L/D) is less than 10, the effects
of shear can not be ignored. Three point bending tests
were used to show the effects of shear. Changing the L/D
ratio from 9.2 to 6.2 for avian bone caused a 32% re-
duction in the elastic modulus when shear was neglected.

PALATABILITY AND ACCEPTABILITY OF THREE STARTER RATIONS FOR
WEANLING LAMBS. Gail Woodbury, William H. McClure and
Elizabeth T. Barnes, VPI&SU, Blacksburg, Va. 24061, and
Southern Seminary Junior College, Buena Vista, Va. 24416
     Lamb data from a cooperative lamb rearing project between
Southern Seminary Junior College, Buena Vista, and Shenan-
doah Valley Research Station, Steeles Tavern, were analyzed
by L.S. procedure of the Statistical Analysis System. Three
ewe lambs and three wether lambs were assigned to two pens,
respectively, and fed three rations free choice for three
weeks.
     In Model I, sources of V included pen (≡sex) and ration.
There were significant differences (P < .01) for amount of
feed consumed in all weeks for ration and in week I for pen.
In Model II, sources of V included pen (≡sex) ration, week,
pen x ration, pen x week. All sources accounted for sig-
nificant variation.
     Wethers consumed 15% more feed than the ewes (P < .01)
LS means for daily consumption of the three rations were
1.43 lb, 2.58 $\pm$ .08 lb, and 3.39 $\pm$ .08 lb.

A GREENHOUSE METHOD FOR TESTING FUNGICIDE ACTIVITY AGAINST
MONILINIA BLOSSOM BLIGHT OF PEACHES. K. S. Yoder, Dept. of
Plant Pathology & Physiology, VPI & SU Fruit Research
Laboratory, Winchester, VA 22601
     A laboratory and greenhouse method was developed to assay
fungicide activity against Monilinia blossom blight of
peaches. Freshly-opened blossoms treated in the field are
selected and excised from shoots and placed on moist sand in
plastic dishes containing 5-20 blossoms per dish. Inoculum
of Monilinia fructicola is grown on potato-dextrose agar and
uniformly atomized onto the excised blossoms as a water sus-
pension containing 25,000 conidia per ml. Blossoms treated
in the laboratory are treated prior to inoculation by mist-
ing the diluted test material onto the blossoms to the run-
off point with an atomizer. Immediately after inoculation
the replicated units are placed in a moist chamber (100% RH)
at 21°C. After a five-day incubation period the percent
discolored area is estimated as an indicator of fungal colo-
nization. Sporulation of blighted petals is evaluated by
suspending the petals in a measured volume of water and
counting the resulting conidial suspension with a hemacyto-
meter.

COMPARATIVE EFFECTIVENESS OF RPAR FUNGICIDES AND ALTERNATIVE
FUNGICIDES FOR APPLE DISEASE CONTROL. K. S. Yoder, Dept. of
Plant Pathology & Physiology, VPI & SU Fruit Research
Laboratory, Winchester, VA 22601
     Standard apple fungicides benomyl, captan, folpet,
mancozeb, metiram, and zineb, currently under RPAR (Rebut-
table Presumption Against Registration) consideration by EPA,
were compared to non-RPAR alternatives dodine + sulfur, fer-
bam and thiram for control of fruit and foliage diseases and
for fruit finish on mature 'Delicious', 'Golden Delicious',
and 'Rome Beauty' apple trees. Recommended rates of the di-
luted materials were applied to replicated single-tree plots
with a high pressure single nozzle handgun. Thiram provided
acceptable fruit finish, but was significantly weaker on
control of scab, rust, sooty blotch, fly speck and Brooks
spot than several of the RPAR fungicides recommended for con-
trol of these diseases. Ferbam provided acceptable control
of scab and rust on foliage and Brooks spot on fruit, but
did not adequately control scab, sooty blotch and fly speck
on fruit. Ferbam also significantly roughened the fruit
finish of the 'Rome Beauty' cultivar. The dodine + sulfur
combination provided adequate control of scab and did not
disturb the fruit finish, but the combination did not ade-
quately control Brooks spot, sooty blotch and fly speck, par-
ticularly on 'Golden Delicious'. Mancozeb provided outstand-
ing overall disease control and fruit finish on all culti-
vars. Captan and metiram significantly improved the finish
of 'Golden Delicious' compared to untreated fruit.

ECONOMIC INJURY LEVEL FOR COCKROACH PEST MANAGEMENT PRO-
GRAMS. P. A. Zungoli*, and W. H Robinson.* Dept. of Ento-
mology, Va. Polytechnic Inst. and State Univ., Blacksburg,
VA 24061
     The pest management concept can be adapted to urban set-
tings to minimize pesticide usage for household pests. It
may be helpful to urban pest management programs to estab-
lish an injury level for important pests.
     A survey of public housing residents was conducted in
Baltimore, MD, Norfolk, VA, and Roanoke, VA in July and
August, 1979. The survey objective was to determine atti-
tudes and level of knowledge of public housing residents
toward cockroaches. Survey results indicate that it may
not be possible to establish an "economic" or "aesthetic"
injury level for urban pest management programs. Eighty-
five percent of the 649 residents questioned felt that
cockroaches were a serious problem, and 48% felt that see-
ing even 2 cockroaches would be a problem. These same res-
idents spent an average of $23.00 over a six-month period
supplementing public housing operated pest control with
store-purchased insecticides, and in some cases, profes-
sional pest control services.

A COMPATIBLE TAPER AND VOLUME MODEL FOR LOBLOLLY PINE.
B. R. Zutter*, and D. M. Hyink*. Dept. of Forestry, Va.
Polytechnic Inst. and State Univ., Blacksburg, VA 24061.
     A tree taper and volume model for loblolly pine is
presented in which cubic-foot volume over a particular stem
length is coincident with an integrated function of stem
taper over that length. This compatible taper and volume
model possesses desirable mathematical and geometric
properties consistent with established mensurational
formulae. Derived from two independently developed volume
ratio models, the integrated volume equation takes the
form of the classical Schumacher ($aD^b H^c$) tree volume
equation. The model may be of particular advantage in
applications involving multiple product yield estimation
since the dimensional attributes of specific products
are independent of the model and may be completely
specified by the user.

Astronomy, Mathematics, and Physics

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

DEEP INELASTIC ELECTRON SCATTERING FROM [56]Fe. R. Altemus*, D. Day*, J. S. McCarthy*, R. R. Whitney*, J. Wise*. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901.
   Deep inelastic electron scattering spectra were obtained at the MIT-Bates Linear Accelerator at 160° 140° and 90° in the energy range of 100 MeV to 370 MeV to 370 MeV. Transverse and longitudinal response functions, in the region of the quasi elastic peak, for vector momentum transfers of 410 MeV/c will be presented. Comparisons with a Fermi gas are included.

HOLE MODEL FOR THE CUPRIC SITE IN BLUE PROTEINS. A. Aqualino* and A. S. Brill*, Dept. of Physics, Univ. of Virginia, Charlottesville, VA 22901.
   A quantum mechanical model that accounts for the unusual spectroscopic properties of the cupric site in the blue protein azurin has been developed. Oscillator strengths and rotational strengths simulated by adjusting the six hybridization parameters of the eight level united atom model are in good agreement with the values determined by analysis of the experimental optical absorbance and circular dichroism (CD) spectra. Adjustment of these parameters fixes the geometry of the binding site. Upon inclusion of orbital reduction factors (ORF), which make explicit the extended radial nature of atomic orbital wavefunctions in a united atom approach, these same parameter values reproduce the principal values of the g and A tensors characterizing the experimental electron paramagnetic resonance (EPR) spectrum. The three ORF, one for each principal direction, indicate the rhombicity in g values is due to extensive differences in hole delocalization.

DYNAMIC SPECTRAL ANALYSIS OF A SYNTHESIZED DOUBLE-REED INSTRUMENT. L. Neel Beard, Dept. of Physics, Hampden-Sydney College, Hampden-Sydney, Va. 23943
   The upper register double-reed voice of a breath-controlled electronic musical instrument has been analyzed. The results of the analysis are presented in terms of amplitude envelopes (amplitude vs. time plots) for each of the first eight harmonics. Several notes have been analyzed.
   Two parallel techniques were used in the analysis:
a) the waveforms were analyzed directly using a General Radio Wave Analyzer; b) the waveforms were digitized with the aid of a microcomputer interfaced to a PDP-11 minicomputer, with subsequent Fourier analysis.
   Each analysis corresponds to a particular value of time in the evolution of the note. In ordinary use, a voltage derived from pressure exerted by the breath alters the amplitude and timbre of the note. For analytic purposes, fixed voltages are substituted for this dynamically changing voltage. This permits a series of static analyses of the dynamic process.
   Much of the work required in this investigation was performed by a group of non-science majors enrolled in a Physics of Music course.
   The results will be compared with published data corresponding to the actual oboe.

DEEP INELASTIC ELECTRON SCATTERING FROM NUCLEI.
H. Bidasaria, P. Fishbane, and J. Noble. Physics Dept., University of Virginia.
   We fit observed inelastic e-He[3] cross-sections in terms of known e-nucleon cross-sections using the impulse approximation. Agreement is good except on either side of the quasi-elastic peak.

LASER-INDUCED DIELECTRIC BREAKDOWN IN UF_6. E. B. Boysen*,
S. S. Fisher, and S. W. Allison*, School of Engr. and Appl.
Sci., U. Va., Charlottesville, VA 22901.
    Several characteristics of dielectric breakdown in UF_6
induced by focusing a high-power, pulsed nitrogen laser in
the gas are described. The principal observable phenomenon
is emission of photons from the breakdown zone (from the
"spark"). This emission is characterized with respect to
its spectrum, its dependence on laser power and gas pressure,
and several other parameters. A second observable process
is the yield of ions. This yield is studied by collecting
ions as a function of the collecting electric-field strength,
and by delaying the time, following the laser pulse, before
this field is switched on. The process is also character-
ized by collecting the resulting precipitate and analyzing
it microscopically and chemically.

LABORATORY DEVELOPMENT OF A HIGH Q CLOCK. W. Stephen
Cheung* and Rogers C. Ritter,* Dept. of Physics,
University of Virginia, Charlottesville, Va. 22901.
    A rotating rigid body in space devoid of all physical
disturbances is an ideal time keeping device ($Q \sim \infty$).
Realization of such a system in the laboratory is one
of the several experiments with intended cosmological
significance being pursued at the University of Virginia.
Two tandem magnetically suspended rotors corotate axially
with the upper rotor protecting and following the lower
one at the same angular speed by appropriate feedback.
Such a mechanism together with low gas pressure, active
and passive shielding will allow the lower rotor to become
a minimally disturbed macroscopic time keeper. A simple
magnetic suspension will be demonstrated, the status of
such development will be reported, and applications
will be discussed. NSF Grant PHY78-03208 and
NBS Grant G8-9025.

THE SPUTTERING OF ICE BY FAST IONS. R. S. Evatt*
and R. E. Johnson, Dept. of Nuclear Engineer. and
Engineer. Physics, Univ. of Va., Charlottesville,
VA 22901. W. L. Brown , W. M. Augustyniak*, and
L. J. Lanzerotti*, Bell Laboratories, Murray Hill,
NJ 07974.
    The sputtering of H_2O ice has been measured
for hydrogen, helium, and carbon ions between 6
keV and 1.8 MeV. The erosion coefficient, S, is
much too large to be explained by the normal (col-
lision-cascade) theory of sputtering due to the
nuclear energy loss, $(dE/dx)_n$, and is related to
the electronic energy loss, $(dE/dx)_e$. S is pro-
portional to $(dE/dx)_e$ for hydrogen and helium ions
in the energy range examined, consistent with a
coulomb repulsion model of the erosion mechanism.
At temperatures greater than 100 K, a thermally
activated erosion process is observed, which is
associated with defect formation and migration in
the ice.

TECHNIQUES FOR MEASURING MAGNETIC ANISOTROPY IN MATERIALS
AND FOR OBSERVING OPTICALLY INDUCED TRIPLET STATES IN
AROMATIC MOLECULES USING A SUPERCONDUCTING SUSCEPTOMETER.
T. L. Fariss,* B. S. Deaver, Jr. and T. J. Bucelot*. Dept.
of Physics, Univ. of Virginia, Charlottesville, VA 22901
and C. J. O'Conner* and E. Sinn*. Dept. of Chemistry,
Univ. of Virginia, Charlottesville, VA 22901.
    The SQUID superconducting susceptometer's combination of
speed and sensitivity allows the development of new methods
for measuring the magnetic properties of materials. Tech-
niques have been developed for measuring magnetic anisotropy
and observing the excited state of an aromatic molecule
which also illustrate the system's versatility. In order to
measure anisotropy, the susceptometer employs two pairs of
pick-up coils. These are arranged so that the magnetiza-
tion of a sample can be measured in two perpendicular direc-
tions simultaneously. By appropriate rotation of the
sample, the magnetization in a direction perpendicular to
the original two can be found. In the second technique, an
ultraviolet laser is used to excite aromatic molecules
into a triplet state. The susceptometer measures the subse-
quent magnetic decay as a function of time, temperature,
and magnetic field, and from this can be found the lifetime,
quantum yield, and absolute magnetic moment of the state.
(Research supported by NSF grant DMR78-25791.)

A NEW SOFT X-RAY DETECTOR. C. Franck,* F. Zutavern,*
E. Källne,* T. Aton,* and S. Schnatterly.* Physics Depart-
ment, University of Virginia, Charlottesville, Va. 22901.
    We have devised and successfully tested a position –
sensitive detector for soft x-rays and vacuum ultraviolet
light. Our device consists of a commercial photodiode
array with element spacing equal to 25 μm, coated with a
high efficiency phosphor, Y_2O_3:Eu. The phosphor is held on
the photodiode surface with a thin layer of glue (water
glass: sodium silicate). Measurements at 78, 89, 95 and
108 eV reveal that the detector yields about 4 electrons
per photon at 100 eV. The detector response increases
linearly with energy in this range.

COUNTING CHAINS OF SETS. H. W. Gould, Dept. of Math.,
West Virginia Univ., Morgantown, W. Va. 26506
    We enumerate chains $X_1 \subset X_2 \subset \cdots \subset X_m \subset X_{m+1}$
of m+1 subsets (m links) connecting two subsets in the
lattice of all subsets of a finite set X of n elements.
For brevity we write ABCD for A,B,C,D and use a dash
(−) in place of the set inclusion sign ($\subset$). A chain
is maximal if $|X_{i+1}| = |X_i| + 1$ for all $i, 1 \le i \le m+1$.
Thus $\emptyset$-A-AB-ABC-ABCD is maximal, $\emptyset$-AB-ABCD is not.
The chains (labelled) A-AB-ABC, B-AB-ABC, A-AC-ABC,
C-AC-ABC, B-BC-ABC, C-BC-ABC may be exemplified by one
chain (unlabelled) A-AB-ABC, of the same type. We show
that the number of unlabelled chains with k links is
$U(n,k) = \binom{n+1}{k+1}$. The number of labelled chains with k
links is $C(n,k) = \sum_{0 \le j \le k} (-1)^{k-j} \binom{k}{j}(j+2)^n$. The number of
labelled chains with k links but omitting the use of $\emptyset$
as a bottom element in any chain is given by $D(n,k) =$
$(k+1)! S(n+1,k+2)$ where $S(n,k) =$ Stirling number of the
second kind (Riordan's notation). Special case: The
number of maximal labelled chains from $\emptyset$ to X itself is
just $C(n,n) = n!$. Tables of the numbers $U(n,k)$, $C(n,k)$,
and $D(n,k)$ are given for $0 \le k \le n$, $0 \le n \le 7$. Many
other enumeration questions arise, e.g. how many chains
link an r-element set to an s-element set? Same query:if
we require the chain to be maximal, or labelled, or
unlabelled, or some combination of such conditions.

RESONANCES IN ATOM-SURFACE SCATTERING. M. Haller*, J. Hutchison*, N. R. Hill*, and V. Celli*, Department of Physics, University of Virginia, Charlottesville, VA 22901.

The scattering of light atoms from the surface of a crystal provides an effective probe of the surface geometry and the atom-surface interaction. The analysis of the scattering intensities when the incident atom resonantly skips along the crystal surface gives especially good detail of this interaction. We present theoretical methods used to interpret recent experimental measurements in this area.

COMPARISON OF EXECUTION TIMES FOR ITERATIVE AND RECURSIVE PROCEDURES ON THE HEWLETT-PACKARD 3000 COMPUTER. Preliminary report. Roger A. Haun* and Diane M. Spresser, Dept. of Mathematics and Computer Science, James Madison Univ., Harrisonburg, VA 22807

The use of recursive procedures in computer programs is controversial, even in those programming languages (such as ALGOL or PASCAL) where recursive calls are a feature inherent to the language. Recursive processes have the advantage that they may be coded in a clear and compact manner. At the same time, they "often execute inefficiently because of the overhead associated with maintaining the recursion and because it is easy to overlook redundant operations."[1]

One might suspect, however, that the overhead associated with recursive procedures would be relatively insignificant on a stack-oriented machine, such as the HP 3000. We use empirical means to compare the execution times required for iterative and recursive procedures. We conclude that significant overhead is associated with recursive procedures, even in stack-oriented machines.

[1] J. L. Pfaltz, Computer Data Structures, McGraw-Hill, New York, 1977, p. 129.

A NIOBIUM SUPERCONDUCTING DETECTOR OF Sub-keV ATOMS. N.F. Henshaw and J.W. Boring*. Dept. of Nuclear Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22903

A low energy particle detector has been constructed using a long, narrow niobium microbridge. The microbridges were typically 50 x 2Å in size and have been made as thin as 75A using both R.F. sputtered films and D.C. sputtered films. A series of I-V characteristic curves have been made at different temperatures and four distinct temperature regimes were noticed and characterized. There is a temperature range in which a normal region due to a thermal hot spot is stable; above this temperature range, the normal region collapses, and below it, the normal region grows.

Operating the detector in the temperature range in which the normal region collapses and current biasing near the critical current for this temperature, the device was able to consistently detect argon ions with energies from 200 eV to 1 keV. The detector efficiency is near 100 percent if the sensitive region of the bridge is used. The pulse heights and widths were independent of the particle energies, from which it is concluded that the pulses were an intrinsic fluctuation phenomena of the material used.

GAS-DENSITY MEASUREMENTS IN UF_6 FREE JETS BY THE RAYLEIGH-SCATTERING METHOD. P. A. Hoisington* and S. S. Fisher, School of Engr. and Appl. Sci., U. Va., Charlottesville, VA 22901.

Gas density distributions in free-jet expansions of UF_6 from converging nozzles into a vacuum chamber are determined by measuring the Rayleigh scattering of laser photons by the gas. For these measurements, a 2W continuous-wave argon-ion laser is focused in the jet at the point of interest and light scattered perpendicular to both the axis and the polarization direction of the laser beam is monitored with a photomultiplier tube. The resolved scattering volume is 0.1 mm in diameter by 1.0 mm long. A photon-counting network is used to measure the scattered light. The smallest density resolved is equivalent to that for UF_6 at 0.003 torr and 300 K. The most accurate measurements have 1σ uncertainties of order 2%. Measured densities are in good agreement with theoretical predictions.

AN ANALYTIC APPROACH TO BOUND-STATE SCATTERING PROBLEMS: THE SCHROEDINGER EQUATION IN ONE DIMENSION. Edward A. Johnson* & H. Thomas Williams, Jr. Physics Department, Washington & Lee University, Lexington, VA. 24450

This paper presents an analytic approach to off-mass-shell scattering problems using the one dimensional, time-dependent Schroedinger equation and elementary quantum physics techniques. Extensive computer graphics assist in the physical interpretation of calculated results.

A rectangular potential barrier centered in an infinite square well models the potential of interest. Investigation of allowable energies as a function of barrier width shows that energy levels occur in odd-even pairs with a predictable spacing between odd and even levels that narrows as the barrier widens. Computer plots illustrate the behavior of the function and provide an explanation for experimental observations.

Fourier techniques are used to form a Gaussian shaped wave packet from individual wave functions. As it sloshes from side to side in the well, the probability density function, Ψ*Ψ, scatters off the barrier. Computer generated snapshots depict a bound-state scattering event in probability space and illustrate the time evolution of Ψ*Ψ.

THE DEVELOPMENT OF AN OPTICAL SYSTEM USING A SPLIT PHOTO-DIODE FOR MAGNETICALLY SUSPENDING A PRECISION ROTOR. G. Jones* and R. Ritter*. Physics Department, University of Virginia, Charlottesville, Va. 22901.

For possible gravitational experiments interest lies in the development of a magnetically suspended precision rotor with Q values of at least 10^{13} to 10^{14}. Since the rotational frequencies of this system will typically be less than 2 Hz, an extremely high decay time and hence a stable nearly frictionless magnetic bearing is required. The magnetic suspension tested uses a split photodiode whose output is fed into a differential circuit. It is known that such a system results in greater thermal stability as well as other improvements to the magnetic bearing. Some studies of rotor dynamics at high vacuum will be presented. NSF Grant PHY78-03208 and NBS Grant G8-9025.

g_J-FACTOR MEASUREMENT IN SULFUR NEGATIVE IONS. R.M. Jopson*
and D.J. Larson*, Dept. of Physics, Univ. of Va., Charlot-
tesville, Va. 22901.

Precision measurements of the internal structure of neg-
ative ions are almost nonexistant due to the difficulty
of obtaining isolated ions for a reasonable length of time.
We describe a general technique for measuring the magnetic
structure of negative ions and apply it to S^-. Approximate-
ly 10^4 ions are stored in a Penning ion trap in a magnetic
field of 0.77 Tesla. 597 nm laser light is used for both
preparing the states and probing the 14 GHz microwave
Zeeman transition. The accuracy of the measurement is
currently limited by the stability of the magnetic field.
This work was supported by the Office of Naval Research.

INELASTIC ELECTRON TUNNELING SPECTROSCOPY. J.C. Lau,
and R. V. Coleman. Dept. of Physics, Univ. of Va.,
Charlottesville, Va. 22901

Inelastic electron tunneling spectroscopy (IETS) is a
sensitive technique for obtaining the vibrational spectra
of molecules at the interface region of metal-insulator-
metal tunnel junctions. Doping the interface regions with
molecules of interest, the tunneling junctions can be
used for the study of chemisorption and interactions at
the interface region.

High resolution doped tunnel junctions using different
combinations of aluminum, magnesium, or tin base electrode
the oxidized film insulating tunnel barrier, and lead,
tin, or silver counterelectrode have been fabricated and
measured. Their spectra show variations due to the
interactions among the adsorbed molecules, the oxides, and
the counterelectrodes. There is evidence to suggest that
IETS can contribute to the understanding of the phenomena
of surface enhanced Raman spectroscopy.
*Supported by DOE contract DE A305-78ER05776

DIAMAGNETIC SHIFTS IN ATOMIC HYPERFINE STRUCTURE. S. J.
Lipson*, Dept. of Physics, Harvard Univ., Cambridge, MA
02138 and D. J. Larson*, Dept. of Physics, Univ. of Va.,
Charlottesville, Va 22901.

Several methods are available for the recently measured
diamagnetic shift in the dipole hyperfine structure of
atomic Rubidium[1]. Shifts in the contact and spin-dipole
components quadratic in applied magnetic field appear in
second order perturbation theory. These have been evalu-
ated by solving the associated inhomogeneous differential
equations[2]. For the hydrogenic case, and analytic solution
has been found which gives the shift as a function of prin-
cipal quantum number. Together with quantum defect theory,
this provides a first approximation for the effect in
alkali atoms.

This work was supported by the National Science Founda-
tion.

1) N. P. Economou, S. J. Lipson, and D. J. Larson, Phys.
Rev. Lett. 38, 1394 (1977).

2) R. M. Sternheimer, Phys. Rev. 146, 140 (1966).

DIFFERENTIAL CROSS SECTION FOR $^9_4Be(p,\pi^\circ)^{10}_5B$ REACTION NEAR
THRESHOLD. M. Madden, D. Jenkins, O.P. Gupta, D. Long,
Virginia Polytechnic Institute and State Univ., Blacksburg,
VA 24061; A. Bacher, M. Pickar, Indiana Univ.; P. Debevec,
Univ. of Illinois.

The angle and energy distribution of gammas for decaying
π°'s from the (p,π°) reaction on ^9Be have been measured at
a proton kinetic energy of 144 MeV. The angle and energy of
each gamma was measured with a lead glass, multiwire-
proportional-chamber telescope. With only s and p-waves,
$d\sigma/d\Omega$ may be expressed as:
$$d\sigma/d\Omega = A + Bcos\theta^* + Ccos^2\theta^*$$
where θ^* = c.m. angle of π° and A,B,C are parameters. The
cross section can be transformed into an angular distribu-
tion for the coincidence photons:
$$N = K (A + BT_1 + CT_2)$$
where K, T_1,T_2 are functions of the measured angles. The
data (226 points) was subjected to a maximum likelihood fit
which yielded the following preliminary values for the para-
meters A, B and C respectively: 0.978, − 0.505 ± 0.176,
0.065 ± 0.045.

ULTRA-HIGH RESOLUTION IR SPECTROSCOPIC ANALYSIS OF OZONE
NEAR 1129 CM^{-1}. L.N. Majorana*, G.E. Copeland, C.N. Har-
ward. Dept. of Physics, Old Dominion Univ., Norfolk, VA.
23508

The analysis of high resolution infrared spectra serves
as an important basis for identification and measurement
of concentration profiles of various atmospheric "pollu-
tant" molecules through remote sensing techniques. The
absorption coefficient and collision broadening parameters
of a selected O_3 transition has been measured for pres-
sures up to 10 torr. This was accomplished in a Beer's
law experiment utilizing a current-tuned $Pb_{1-x}SnSe$ diode
laser as a radiation source. Computerized data collection
and analysis has led to the development of unique inter-
active software which is useful in a general way for spec-
troscopy of this type.
(Partially supported by NASA-LaRc-Grant NSG 1466)

METHODOLOGY FOR MULTIELEMENT NEUTRON ACTIVATION ANALYSIS OF
TRACE AND MINOR ELEMENTS IN XYLEM TISSUE. P. W. Marshall*
and John R. Gordon. Dept. of Physics, James Madison Univ.,
Harrisonburg, VA. 22807

A methodology has been developed for determination of
concentrations of trace and minor elements in tree-ring
xylem tissue using instrumental neutron activation analysis.
Absolute multielement calculations have been made using
photopeak integrals from the gamma-ray spectra of the
activated samples, measured counting efficiencies, and a
data file of nuclear properties. The accuracy of the pro-
cedure was tested using two standard reference materials.

Both angular and radial variations in the elemental
composition of tree-ring xylem representing two locations
have been determined for the following eleven elements:
Na, K, Ca, Mn, Fe, Co, Zn, Br, Rb, La, and W. The results
showed angular changes that ranged from 100 to 300 percent
of the average value for a given element. The changes in
the elemental concentrations which were found radially along
a growth increment corresponding to a 100 year time interval
were analyzed as ratios relative to sodium. Those elements
involved in active transport during the growth cycle
exhibited expected changes from sapwood to hardwood; while
evidence of long range changes in environmental conditions
at the sample site were observed for a limited number of
elements.

These results were not surprising in view of the previous
findings of more limited studies.

AN INTERPRETATION OF QUANTUM MECHANICAL MEASUREMENT.
M. T. Milbocker*, Dept. of Physics, Kempsville High
School, Virginia Beach, Virginia 23462
    The author has outlined several of the more important
interpretations of measurement in quantum mechanics and
discussed the problems arising from them. Particular
attention was paid to the work of Bohr, Heisenberg, and
von Neumann and a tentative proposal was made for a pos-
sible interpretation which would mitigate some of the
problems and dilemmas. This interpretation was essentially
that proposed by Margenau in terms of latent variables.
He defines measurement to be any operation with physical
apparatus which results in a number. Further he makes the
distinction between the preparation of a state and the
measurement of the state. A preparation puts the quantum
system into a particular state whereas the measurement
frequently destroys the state in question. This paper
presents several criteria to help in the evaluation of
the alternatives presented and carries further the
suggested interpretation mentioned by Margenau.

NEW WRINKLES ON OLD DEMONSTRATIONS. R.B.Minnix and
D.R. Carpenter, Jr. Physics Dept. Va. Military
Inst., Lexington, VA 24450.
    Old demonstrations viewed by a new observer for
the first time often trigger fresh ideas on how to
make a physical principle come alive for students.
In short courses on physics demonstrations given
since 1973 at VMI, participants have left behind a
rich legacy for future use.
    Bernoulli's Principle can be shown in the curv-
ing of styrofoam balls, of toilet paper rolls and
styrofoam cups propelled forward and spinning with
rubber bands wrapped around them. An indoor tor-
nado can be formed by inverting a round gallon jug
filled with water to which a swirling motion has
been imparted.
    The notes of both a closed and an open tube,
one octave apart, can be sounded by patting the
end of the tube with a flattened palm.   Square
waves can be synthesized using a violin bow to
excite a taut wire. The pattern is made visible
on an oscilloscope using the voltage generated in
the wire as it moves between the poles of a strong
magnet placed at the wire's mid-point.
    The principle of a measurement being disturbed
by the measuring instrument can be illustrated
using a meter stick to measure a column of water
in which it is immersed.

PION ABSORPTION IN THE HELIUM ISOTOPES. L. Orphanos*,
R. Altemus*, P. Gugelot*, J. Källne*, J. McCarthy*, R.
Minehart*. Dept. of Physics, Univ. of Virginia,
Charlottesville, VA 22901. P. Gram,* B. Höistad,* C. Morris,*
E. Wadlinger,* Los Alamos Scientific Lab, Los Alamos, NM
87544. C. Perdrisat,* Dept. of Physics, College of William
and Mary, Williamsburg, VA 23185.
    We have measured the differential cross-section of
$^{3,4}He(\pi^-,n)^{2,3}H$ above the $(3,3)$ resonance using the p^3 pion
channel at LAMPF. The reaction was measured for pion kinetic
energies $T_\pi = 285-575$ MeV, using the recoil detection
technique to measure TOF, ΔE, and E of $^{2,3}H$. Angular dis-
tributions $\frac{d\sigma}{d\Omega} (\theta, T_\pi)$ will be presented and interpreted
within the framework of various models.

NEUTRON FLUX DISTRIBUTION FROM A TOROIDAL PLASMA SOURCE.
W. G. Pettus, Babcock & Wilcox Co., Lynchburg Research Cen-
ter, Lynchburg, Va. 24505
    The first fusion power reactors will most likely be of
the tokamak type and will employ the deuterium-tritium reac-
tion. The tokamak is a magnetic plasma confinement device
in which the reactor vessel is of toroidal shape. Most of
the energy released in the D-T reaction is carried by high
energy neutrons which pass through the vessel wall and are
absorbed in a surrounding blanket region.
    Because of the toroidal distribution of the source, the
neutron distribution at the wall is, in general, non-uniform.
This variation can have important consequences in terms of
blanket reaction rates and radiation damage to the wall. In
principle, a measurement of the flux distribution at the wall
can also be used to infer the distribution of the fusion
reactions and to identify certain plasma parameters.
    This paper presents a convenient analytical formulation
of this flux distribution and discusses possible applica-
tions with respect to radiation damage and plasma diagnostics.

PRIMARY ELECTRON PEAKS IN ELECTRON ENERGY DISTRI-
BUTIONS IN MULTIDIPOLE ARGON PLASMAS. J. W.
Sealock* and G. R. Taylor, Physics Department,
James Madison University, Harrisonburg, Va. 22807
    The presence of primary electrons as a second
species in the electron energy distribution in
argon plasmas is observed by operating a multi-
dipole plasma device at low neutral pressures in
an unconventional manner. The mean energy of the
primary electron distribution is shown to vary
linearly with the effective plasma discharge
voltage. The change in the plasma potential with
the effective discharge voltage is shown for
constant secondary electron current. The plasma
characteristics are determined from electrostatic
probe characteristics using a modified Druyvesteyn
method.

A DOUBLE CRYSTAL MONOCHROMATOR FOR SYNCHROTRON
RADIATION. D.J. Scherer and W.C. Sauder, Dept.
of Physics, Va. Military Inst., Lexington, VA
24450, and W.P. Trower, Dept. of Physics, VPI&SU,
Blacksburg, VA 24061.
    We present a design for a monochromator for use
with synchrotron sources based upon the principles
of the monolithic double crystal spectrometer[1].
The output beam is diffracted into a segment from
30° to 150° from the forward beam direction as
the instrument is set for detailed scanning in
regions from 2.8 Å down to 0.6 Å. High disper-
sion scanning takes place in a plane perpendicular
to the synchrotron orbit. The instrument is
characterized by very high resolution and the
elimination of higher orders.

[1]William C. Sauder, James R. Huddle, J.D.
Wilson, and Robert E. LaVilla, Phys. Lett. 63A,
313 (1977).

ANALYSIS OF SUPERCONDUCTING WEAK LINKS USING A COMPUTER MODEL. J. L. Spencer*, and B. S. Deaver, Jr. Dept. of Physics, Univ. of Virginia, Charlottesville, VA 22901.
   A simple phenomenological model of a superconducting weak link has been implemented on a computer. The shape of V-I curves generated by the model is shown for a wide range of pair relaxation times. The curves closely match experimental data exhibiting hysteresis when long relaxation times are used, as well as non-hysteretic data at short relaxation times. Time and phase relations for instantaneous voltage and for pair density are explored to find the origin of hysteresis. (Research supported by NSF grant DMR78-25791.)

MUON SPIN ROTATION STUDIES OF IRON DILUTED WITH SMALL AMOUNTS OF TRANSITION METALS. C. E. Stronach, Va. State Univ., Petersburg, Va. 23803; B. D. Patterson*[†] and A. S. Arrott*, Simon Fraser Univ., Burnaby, B. C., Canada; A. T. Fiory*, Bell Laboratories, Murray Hill, NJ 07974; W. J. Kossler*, Col. of William & Mary, Williamsburg, Va. 23186; W. F. Lankford, George Mason Univ., Fairfax, Va. 22030
   Positive muons from the TRIUMF cyclotron were implanted in samples of Fe alloyed with small (typically 2-4%) concentrations of impurity elements. Temperatures ranged from near room temperature to about 630K for Fe(Mo) and Fe(Nb), and to 525K for Fe(Ti). The contact hyperfine fields were determined by subtracting the Lorentz fields from the B_μ obtained from the precession frequencies, and were compared with those observed in pure Fe. The low-temperature behavior suggests that the Mo, Nb, and Ti impurity sites are attractive to the μ^+, and the high-temperature behavior suggests that the Mo decreases the magnitude of the hyperfine field less than that expected for pure dilution, Nb approximates pure dilution, and Ti reduces its magnitude more than expected from pure dilution. (Supported by NASA, NSF, National Research Council of Canada, and the Commonwealth of Virginia)
[†]Present address: Univ. of Zurich, Switzerland.

EFFECTS OF POLARIZATION ON π° SCATTERING. M. C. Sullivan and D. A. Jenkins, Virginia Polytechnic Institute and State Univ., Blacksburg, VA 24061
   Measurements of the π° differential cross section near threshold of (p,π°) reactions have been made using an unpolarized proton beam. This is done by measuring the γ distribution produced by $\pi^\circ \rightarrow \gamma + \gamma$ and assuming only s and p waves in the π° angular distribution. It is now useful to investigate the effects of using a polarized beam on the γ distribution measured in the experiment. The π° cross section equation has been analyzed with the result that certain areas in the γ distribution are sensitive to beam polarization. For example, if γ are counted at 90° and -90° from the beam with azimuthal angles of 240° and 90° the differential cross section varies with beam polarization.

DATA ACQUISITION THROUGH RTMULTI WITH A SINGLE-DATA TRANSFER CONTROLLER. R. Vaughan and D. Jenkins, Physics Department, Virginia Polytechnic Institute and State Univ., Blacksburg, VA. 24061.
   RTMULTI is a data acquisition system developed at Fermi Lab for a Jorway 411 DMA controller.[1] The system has a data acquisition component and a component called MULTI for data analysis and control. We have incorporated a data acquisition section which uses a EGandG DC011 crate controller on both a PDP11/34 and PDP11/40 computer. The system uses components which are commercially available.
   1. RT/RSX MULTI: Packages for Data Acquisition and Analysis in High-Energy Physics, Bartlett, Biel, Curtis, Dosen, T. Lagerlund, Ritchie and Taff, Submitted to Topical Conference on Computerized Data Acquisition Systems in Particle and Nuclear Physics, 1979.

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PASSAGE OF HOST ANTIBODY ACROSS THE DIGESTIVE TRACT OF THE AMERICAN DOG TICK, DERMACENTOR VARIABILIS, Steven Ackerman, F. Brian Clare, T. W. McGill, and Daniel E. Sonenshine, Dept. of Biol. Sci., Old Dominion Univ., Norfolk, VA 23508.

The ability of host macromolecules to pass across the digestive tract into hemolymph of female ticks was investigated. Electrophoretic and immunologic analyses detected various serum constituents in hemolymph following infestation on rats or rabbits or following artificial feeding of whole serum or purified serum substances. The effects of digestion and/or transport of these macromolecules on protein structure and antigenicity was examined. Furthermore, host antibodies were detected on salivary glands or ovaries dissected from ticks infesting rabbits immunized with extracts of these organs. No antibodies were detectable on 1) organs from ticks infesting a non-immunized rabbit, 2) salivary glands from ticks infesting a rabbit immunized with ovary extracts, or 3) ovaries from ticks infesting a rabbit immunized with salivary gland extracts. The implications of this ability of antibodies directed against internal organ antigens to pass across the ticks digestive system, while retaining specific antibody activity, will be discussed with regards to the development of an anti-tick vaccine.

ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA) FOR THE DETECTION OF ANTIBODIES TO HUMAN SPERM. Steven Ackerman, William Garrison, J.W.E. Wortham, R. James Swanson, and Julian Gutierrez., Dept. of Biol. Sci., Old Dominion Univ., Norfolk, VA 23508.

Among the 60 million reproductively-active American couples, it has been estimated that approximately 15% experience infertility problems. In many cases, infertility can be correlated with antibodies to human sperm occurring in either the serum and/or cervical mucus of the female or in the serum and/or seminal plasma of the male. In the Andrology Laboratory of Old Dominion University we currently test for antisperm antibodies via immobilization and agglutination procedures. This report outlines the development of a novel assay to identify, quantitate and characterize antisperm antibodies via enzyme-linked immunosorbent assay (ELISA). Data will be presented to indicate optimal incubation parameters, antigen concentrations and methods of quantitation. Results to data indicate that the ELISA method for detection of antisperm antibodies is a relatively simple, extremely sensitive, and, in many ways, preferable assay than others currently in clinical use.

THE EFFECTS OF ESTRADIOL BENZOATE ON THE CARDIOVASCULAR SYSTEM OF THE RAT. S. M. Ashe*, T. W. Toney, and L. G. Martin. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

The effects of estradiol benzoate on coronary blood flow in the adult female rat was studied. Female control rats, castrates, and castrates receiving estrogen were used. Tracer microsphere studies of myocardial blood flow allowed the quantitation of the effects of estrogen upon the coronary circulation. It would thus appear from data that estrogen does have the ability to modulate coronary blood flow. (Supported in part by ADA Grant 90-A-1245(02) awarded to the Virginia Center on Aging, ADA Grant 90-A-1392(01) awarded to the Dept. of Gerontology, Va. Commonwealth Univ., and Faculty-Grant-in-Aid #1-93035 awarded to Loren G. Martin, Va. Commonwealth Univ.)

SOCIAL ENVIRONMENT AND SEXUAL MATURATION IN MALE PRAIRIE DEER MICE, PEROMYSCUS MANICULATUS BAIRDI. T.E. Babb and C.R. Terman. Dept. of Biology, College of William and Mary.

Male deermice, 21-24 days of age were placed into the following adult social situations: with 6 females, 6 males, 3 males puls 3 females, single female, single male, and isolated (control). After 14 days the young were killed and their testes and seminal vesicles weighed. The testes and seminal vesicles of young reared with any group containing adult males were significantly smaller than those of controls. The seminal vesicles of males housed with single females were significantly larger than all other treatments.

The effectiveness of urine versus physical contact on maturation was tested in a subsequent experiment. Young males 21-24 days old were placed with adult males or adult females exposed to urine of adult males or adult females, or exposed to distilled water. Urine was collected every other day and refrigerated. Three strokes of a #2 artist's paint brush, freshly dipped in urine or water were applied daily in a designated corner of the appropriate cages. Young were killed at 40 days of age. The results showed that the seminal vesicles of males in contact with adult females or exposed to the urine of adult females were significantly larger than those exposed to the other treatments. Males in contact with adult males had smaller testes and seminal vesicles than those exposed to water or in contact with females or female urine. Exposure to male urine did not significantly influence the testes or seminal vesicles size compared to water.

THE RELATIONSHIP BETWEEN LARVAL BLUEGILL SURVIVAL, PARENTAL CARE, AND FISH PREDATION. M. B. Bain*, and L. A. Helfrich*. Dept. of Fisheries and Wildlife Sciences, VA Polytechnic Inst. and State Univ., Blacksburg, VA 24061

The effect of nest preparation and guarding on the survival of larval bluegill (Lepomis macrochirus) was investigated. Larval bluegill mortality was estimated for a total of 77 guarded and unguarded nests (guard artificially removed).

Larval bluegill mortality due to fish predation was found to be significantly greater (p=.001) in unguarded nests. Juvenile bluegill (3-14 cm) dominated the fish community (91%). The dominate nest predators were juvenile bluegill 7-11 cm. Larval bluegill mortality was not correlated with the density of juvenile bluegill or the density of nest predators. Fish traps placed in unguarded nests caught significantly more fish (p=.0004) and a greater size-range of fish than traps placed in guarded nests. Substrate analysis indicated that nest preparation substantially increased the abundance of coarse gravel (8-32 mm) and pebbles (32-64 mm) in the nest. The interstitial space between these particles provided refuge for larval bluegill. Mortalities declined as the abundance of large particles increased (p<.05).

The results indicate that the nest preparation and guarding activities of the male parent increases survival of larval bluegill. Nest preparation alters substrate composition to provide concealment of larvae. Nest guarding reduces the number of actual nest predators.

EVALUATION OF SMALL RODENT POPULATIONS AT FOUR DISMAL SWAMP STANDS. F. E. Breidling*, F. P. Day, Jr., R. K. Rose*. Department of Biological Sciences, Old Dominion University, Norfolk, Va. 23508.

Small rodent populations of four Dismal Swamp stands are currently under investigation to determine the causes of the low density and variety of small rodents, and to compare populations among the four stands. Rodents were live-trapped in May and October 1979, while flood levels were checked. Mast and other fruits are being collected. "Cafeteria" tests are under way; fruits will be analyzed as to caloric value and nutrient content. Live-trapping has yielded low numbers of Peromyscus leucopus and Ochrotomys nuttalli. Flooding appears to affect species diversity but not density. Mast availability is low, and may limit the size of rodent populations. (Supported by VAS grant).

A MORPHOLOGICAL INVESTIGATION OF Xenopus laevis DEVELOPMENT USING THE SCANNING ELECTRON MICROSCOPE. Barry L. Browder* and Carolyn M. Conway, Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284, Ian Uydess, Philip Morris Res. and Development Ctr., Richmond, Va. 23261, and A. F. Conway, Dept. of Biology, Randolph-Macon Col., Ashland, Va. 23005.

A morphological study of developmental processes in Xenopus laevis was conducted using the scanning electron microscope. Developing specimens (first cleavage through early third form tadpoles) were dejellied, fixed, critically point dried, sputter coated with gold-pallidium, and examined in a JOEL-JM/35A SEM. Morphological parameters investigated were cell shape changes, appearance of microvilli and cilia, as well as the external morphology of organ primordia and definitive structures. During cleavage (stage 8) microvilli were observed in numerous cleavage furrows of the animal pole. Microvilli were also observed in early gastrulae (stage 10½) on the invaginated dorsal lip and on cells in the blastoporal groove. Ciliary tufts first appeared just before completion of neural fold fusion (stage 20). These ciliary tufts increased in number and location as development proceeded. Lateral line organs of early 3rd form tadpoles (stage 49) were observed to have cupulae extending from the center of each. The findings of this study suggest that a more extensive study of morphological changes during X. laevis development needs to be conducted with both scanning and transmission electron microscopes. (Supported by Philip Morris, USA, and Va. Commonwealth Univ.)

INFLUENCES OF FOREST CONVERSION ON SONGBIRD COMMUNITIES IN THE CENTRAL PIEDMONT OF VIRGINIA. E.L. Childers*, T. L. Sharik, and C. S. Adkisson*. Dept. of Fisheries and Wildlife Sciences and Dept. of Biology, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

Bird sampling transects 100 m long by 50 m wide were established in loblolly pine plantations ranging in age from 1 to 42 yrs. and in second-growth native pine-hardwood and hardwood stands. Each of several developmental stages of the pine plantations and the native forests were represented by three replicates, for a total of 39 sample stands. During late summer (July 17 - September 6) of 1979 each transect was sampled three times in 30 minute periods between 0530 and 0900 EST. Bird species density and diversity were found to be relatively high in the young pine plantations (1-10 yrs) and the more mature pine plantations (25-42 yrs). Species numbers and diversity were relatively low in the intermediate aged pine plantations (11-24 yrs) and in the native forest stands. A total of 41 bird species were observed on transects during the sampling period.

ASSOCIATION OF SEMEN FACTORS WITH THE RECOVERY OF UREAPLASMA UREALYTICUM. Rebecca Cintron, J. W. E. Wortham and Anibal Acosta. Dept. of Biol. Sci., Old Dominion Univ., Norfolk, VA 23508.

Ureaplasma urealyticum (T-mycoplasma) has generated considerable interest to clinical investigators since its discovery in 1954 because of the high incidence of recovery from cases of nonogonococcal urethritis, spontaneous abortions and female urogenital infections. Ureaplasmas are suspected etiologic agents of human infertility. The routine investigation of an infertile marital unit typically excludes the detection of ureaplasmas in cultures of semen and cervical mucus. The Andrology Laboratory of Old Dominion University has examined the potential effects of Ureaplasma urealyticum on various parameters of semen quality in the subfertile male. Differences between sperm count, ejaculate volume, sperm morphology, sperm motility and sperm viability are compared between ureaplasma positive and ureaplasma negative semen specimens.

ROLE OF MATERNAL AUTOIMMUNITY IN CHROMOSOMAL NONDISJUNCTION AND NEONATAL SURVIVAL IN MICE. Carolyn M. Conway, Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284, and A. F. Conway, Dept. of Biology, Randolph-Macon Col., Ashland, Va. 23005.

Maternal autoimmune disease results in increased chromosomal nondisjunction and reduced neonatal survival in offspring of CD-1 mice. Approximately 10% of the offspring of females immunized with thyroid homogenate were aneuploid. Approximately 50% of the offspring produced by all immune stimulated females (both thyroid specific and non-specific) were chromosomal mosaics (less than 70% of cells exhibiting identical chromosome numbers). In addition neonatal survival for offspring of females immunized with thyroid homogenate was reduced as compared to neonatal survival of offspring of non-specific immune stimulated and control females. Less than 25% of the offspring of thyroid immunized females survived to 21 days post-partum. The higher percentage of mosaic offspring indicates that immune stimulation affects post-fertilization chromosomal nondisjunction to a greater extent than chromosomal nondisjunction during oogenesis, suggesting that maternal immune stimulation results in an alteration of the environment within the female reproductive tract. These results also suggest a correlation between the type and stage of the maternal immune response during embryogenesis and neonatal survival. (Supported by the Grants-In-Aid Program for Faculty of Va. Commonwealth Univ.)

DEMOGRAPHIC PATTERNS OF MICROTUS PENNSYLVANICUS POPULATIONS IN OLD FIELD COMMUNITIES. J. A. Cranford, T. L. Derting* and D. H. Pistole, Dept. of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

A population of meadow voles (Microtus pennsylvanicus) in Blacksburg, Va. was live trapped monthly from Oct. 1977 to Nov. 1979. All individuals were aged and toe clipped on initial capture, and on all captures they were weighed, measured and their reproductive condition determined. This population exhibited a typical annual cycle of increase and decline as well as a portion of a classic three year cycle. During the low subsequent to the peak species diversity increased with the addition of four new species of rodents previously uncaptured in this habitat. The microtus grid was located on the optimum habitat in this area so corridors of dispersal could be studied during the periods of high population density. Movement into and through adjacent habitats was not random but followed rather predictable corridors with high levels of protective cover. Some of these corridor areas were never acceptable habitats for permanent residence but provided access to other areas which were subsequently colonized. Growth and development of individual cohorts will be reported on as well as general loss patterns within the population.

THE FATE OF AEROSOL LEAD IN TERRESTRIAL FOOD CHAINS. Robert W. Elias. Dept. of Biology, Va. Polytechnic Inst. and State Univ., Blacksburg, Virginia, 24061

Atmospheric lead enters terrestrial food chains by dry and wet deposition. Dry deposition of aerosol particles occurs on plant and animal surfaces where it enters the food chain directly through food acquisition, grooming, and inhalation, or indirectly through transfer to the soil by rain washoff.

Lead from wet deposition (rain or snow) or from washoff of dry deposits from plant surfaces is largely retained by the organic fraction of the soil. Some of this lead is transferred to soil moisture where it is taken up and stored in the internal tissues of plants. A small portion of the soil lead leaves the ecosystem as surface runoff.

Data are presented which show that atmospheric inputs of dry deposition in a subalpine ecosystem are 40-60% of the total input to the ecosystem, that more than 50% of the lead which enters the food chain directly is from surface deposition, and that less than 1% of the incoming atmospheric lead is removed from the ecosystem by surface runoff. Preliminary data are used to estimate the transfer of lead from vegetation surfaces to the soil and from the soil to soil moisture.

PHYSIOLOGICAL EFFECTS OF XYLAZINE HYDROCHLORIDE (ROMPUN) APPLICATIONS IN TWO SPECIES OF MICE. David F. Gibson , Susan M. Muth and Patrick F. Scanlon . Dept. of Fisheries and Wildlife Sciences., Va. Polytechnic Inst. and State Univ. Blacksburg, VA 24061

Female Mus musculus (ICR Strain) and laboratory-raised male white-footed mice (Peromyscus leucopus) were injected (i.p.) with a 1% solution of the immobilizing drug xylazine hydrochloride (Rompun) at rates of 20 to 160 mg/kg B.W. The median lethal dose (LD_{50}) for Mus was between 70 and 80 mg/kg B.W. Using 4 Mus per treatment, a significant (P<0.001) difference was observed among dose rates with regard to induction and sleeping times which were both dose-dependent. However, this was not reproduced in a replication using 10 Mus per treatment. Packed cell volume (PCV), total plasma proteins (TPP) and total plasma corticosteroids varied significantly (P<0.001) with dose rate of Rompun in Mus but directions of changes were not dose dependent. PCV in Peromyscus did not vary with Rompun dose. TPP changes were inconsistent and corticoids were not significantly different among dose rates of Rompun. However variability in corticoid concentrations was high. Plasma glucose concentrations were significantly (P<0.001) different among different xylazine dosages with the response being dose dependent. Both species appear to be unsuitable models for testing on Rompun effects on blood characteristics.

METHODS OF HYPERPLASTIC LIVER NODULE PRODUCTION IN LABORATORY RATS AND MICE. R. E. Craven* and W. P. Trower, Dept. of Physics, VPI & SU, Blacksburg, VA 24061

The study of hyperplastic liver nodules is an important area in cancer research. The rapid and uniform induction of these nodules is essential and methods for nodule induction in rats have been developed using the procedures of differential inhibition (Solt & Farber, Toronto) and differential stimulation (Schulte-Hermann, Marburg). These methods have been used in laboratory mice at VPI & SU. Using differential inhibition, C57-BL mice were exposed to the carcinogenic diet of 2-acetyla-minoflourene (2-AAF) and a partial hepatectomy. Weeks after partial hepatectomy, hyperplastic nodules were not found. It was concluded that the 2-AAF had little effect on the mice, a possible indication that carcinogenic suseptibility may be due to the physiological differences between rats and mice.

Recently at VPI & SU, differential stimulation was attempted in BALB/c and C3H mice using a single DEN inoculation and successive α-hexachlorocyclohexane (α-HCH) intubations. Null results were obtained due to an overdose of α-HCH. Currently this method is being attempted in Fischer-344 rats. (Supported in part by the ACS).

VEGETATIONAL CHANGES ASSOCIATED WITH FOREST CONVERSION IN THE CENTRAL PIEDMONT OF VIRGINIA. A. C. Felix, III*, T. L. Sharik, and B.S. McGinnes*. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst., Blacksburg, VA 24061.

Vegetation composition and structure were quantified in 21 converted stands on the Buckingham-Appomattox and Cumberland State Forests; 3 replications of 7 seral stages varying from 1-22 yrs. were selected. In converted stands, succession was greatly accelerated due to a large seed pool and rapid canopy closure from co-developing loblolly pine and coppice hardwoods. The process was exemplified by comparing changes in species variety, evenness, and vegetative coverage within the ground stratum (<1m). Variety and vegetative coverage showed the same trend: high values in stands 1-5 yrs. of age followed by a continual decline from 5-15 yrs., at which point canopy closure is complete and these variables are relatively constant for the next 7 yrs. Evenness over time was fairly constant, except for 3 yr. old stands where a decline occurred owing to extensive coverages by Andropogon virginicus and to a lesser extent, Rubus and Rhus spp. The Shannon-Wiener index, an integrator of variety and evenness, was more indicative of varietal changes because of the constancy of the evenness component. (Aided by NWF Fellowship)

EFFECTS OF XYLAZINE HYDROCHLORIDE (ROMPUN) ON RESPIRATION RATES AND RECTAL TEMERATURES OF WHITE-TAILED DEER. David F. Gibson*, P. F. Scanlon and R. L. Kirkpatrick. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, VA. 24061

Forty-five attempts to immobilize female white-tailed deer, Odocoileus virginianus , (age 5-6 y. o.) were made using a 10% solution of xylazine hydrochloride (Rompun). Respiration rates and rectal temperatures were measured at immobilization, and at 15, 30 and 90 minutes after immobilization. Respiration rates were irregular during recumbency but remained low throughout. Deer characteristically exhibited intermittent periods of apnoea and hyperpnoea within the 30 minutes after injection. Deep/slow and rapid/shallow respiration rates were noted in many deer. Rectal temperatures declined throughout immobilization. Mean temperatures were 39.4±0.1C, 39.3±0.1C, 38.9±0.1C and 38.1±0.2C; (±S.E.), respectively, for each of the observation times. In one male white-tailed deer (age 2.5 y.o.) a rectal temperature drop of 4.8C was recorded 8 hours subsequent to xylazine injection.

DOSE RATES OF XYLAZINE HYDROCHLORIDE (ROMPUN) FOR THE IMMOBILIZATION OF WHITE-TAILED DEER. David F. Gibson*, Patrick F. Scanlon, Robert J. Warren*, Anne Oelschlaeger*, and Roy L. Kirpatrick. Dept. Fisheries and Wildlife Sci. Va. Polytechnic Inst. and State Univ. Blacksburg, VA 24061.

Adult white-tailed deer (Odocolileus virginianas) were immobilized with the drug xylazine hydrochloride (Rompun). In 86 instances female deer (age 5-6 y.o.) ranging in weight from 41.0 to 83.5 kg were injected with 10% xylazine at different dose rates; 73% were effectively immobilized. A total of 108 attempts to immobilize male deer (age 2-3 y.o.) ranging in weight from 51.0 to 96.0 kg was performed with 94.4% considered effectively immobilized. Effective immobilization was determined to be the period of 90 minutes over which deer could be bled by venipuncture. Dose rates of xylazine for female deer ranged from 0.74 to 3.82 mg/kg B.W. and for males, 1.60-3.37 mg/kg B. W. Despite different dose rates, mean induction times were similar between males (10.5 min±0.8 S.E., N=104) and females (10.8 min±0.8 S.E., N= 76). The common xylazine concentration used was 10%, however, 5% and 1% were also effective in immobilizing deer. It is suggested that a dose rate of approximately 1.0 mg/kg B.W. (10% xylazine is suitable for periods of short immobilization in white-tailed deer, e.g. single bleedings, antler removal or hoof trimming. For longer periods of immobilization, e.g. serial bleedings, minor surgery etc., a dose rate 1.0 mg/kg is suitable.

ELECTROPHORETIC DIFFERENTIATION OF STRIPED BASS SPAWNING AGGREGATES FROM KERR RESERVOIR, VA-NC. C. J. Guse*, J. J. Ney, and B. J. Turner.* Dept. of Fisheries and Wildlife Sciences and Dept. of Biology, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

The self-sustaining striped bass population of Kerr Reservoir spawns in both the Roanoke and Dan Rivers. This study was undertaken to determine if genetic variation, indicative of reproductive isolation, occurred between the two spawning aggregates.

The enzyme products of fifty structural loci were surveyed in 18 individuals collected from each river in 1979. Of these, creatine kinase, inorganic pyrophosphatase and inosine triphosphatase were found to be polymorphic. Each isozyme conformed to Hardy-Weinberg equilibrium and was independent of sex and age. Allele frequencies differed significantly ($P<0.05$) between rivers for all three loci.

The 1980 spawning runs will be similarly analyzed to further determine the degree of reproductive isolation. The existence of discrete subpopulations of striped bass in Kerr Reservoir has implications for effective management of both the fishery and the spawning streams.

RATE OF PASSAGE OF FOOD AND DAILY PERIODS OF MAXIMUM AND MINIMUM FOOD CONSUMPTION BY CAPTIVE RUFFED GROUSE. G. D. Harris*, G. W. Norman*, and R. L. Kirkpatrick. Dept. of Fisheries and Wildlife Sciences, Va. Polytech. Inst. and State Univ., Blacksburg, Va. 24061.

Food consumption by seven pairs of captive ruffed grouse (Bonasa umbellus) was monitored at two hour intervals over a three day period to establish periods of maximum and minimum food consumption. The amount consumed was determined by removing the individual feed bowls at two hour intervals and weighing the contents. The grouse were fed a diet of commercial game bird feed. The period of average maximum food consumption was determined to be 3 p.m. till 5 p.m. when the grouse consumed approximately 25% of their total daily consumption. The period of average minimum food consumption was determined to be 7 a.m. till 9 a.m. when the grouse consumed approximately 8% of their total daily consumption. Three grouse were force-fed capsules of ferric oxide dye in the evening prior to roosting and three more grouse were force-fed identical capsules the next morning to determine the rate of passage. The feces of all six grouse were monitored for traces of the dye over the next two days. The grouse which had ingested the dye in the evening took approximately 43 hours on the average to completely pass the dye while the grouse which had ingested the dye in the morning took an average of only 30 hours to completely pass the dye.

ISOELECTRIC FOCUSING STUDIES OF HUMAN SEMINAL PLASMA PROTEINS. H. Scott Hardison, James H. Yuan , and J.W.E. Wortham, Jr. , Departments of Biological Sciences and Chemical Sciences, Old Dominion University, Norfolk, Va., 23508.

The isoelectric focusing technique has been adapted for the analysis of human seminal plasma proteins. Protein subunits were separated according to their unique isoelectric points in a 7% acrylamide gel containing 9M urea and 2% ampholyte in which a stable pH gradient of 4.5 to 8.5 has been formed. The effects of time, and frequency of emission on banding patterns were studied. Deviation in banding patterns were correlated with basic semen parameters. The establishment of a normal protein "profile" may enable detection of abnormal protein constituents in patients undergoing fertility examination. By separating, isolating, and identifying both normal and abnormal protein species, insight may be gained regarding the molecular nature and relationship of these proteins to fertilization.

THE EFFECT OF A DIETARY MANGANESE SULFATE SUPPLEMENT ON AFLATOXICOSIS IN THE MALE GOLDEN HAMSTER (Mesocricetus auratus). C. E. Hastings, Jr. and G. C. Llewellyn. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

Aflatoxin is a highly potent hepatotoxin and hepatocarcinogen in many animals including the hamster. This study evaluated the effect of manganese on the precancerous changes associated with aflatoxicosis. Thirty-two male, weanling hamsters were divided into four groups, each with eight animals. The groups were differentiated according to their diet as follows: (1) Control diet - Purina Laboratory Chow #5001, (2) control diet plus 1149 ppm manganese, (3) Control diet plus 37.32 ppm total mixed aflatoxin for six weeks, followed by 18.66 ppm aflatoxin for the next two weeks, and 29.99 ppm aflatoxin for the final two weeks of the experiment and, (4) control diet plus both the aflatoxin and manganese supplements. All animals were sacrificed at the end of ten weeks. The expected depressed weight gain due to aflatoxin was potentiated by the manganese addition. Bile duct cell proliferation, enlarged nuclei, and nuclear inclusions caused by the aflatoxin were reduced by the manganese supplement. Aflatoxin was shown to cause increased liver glycogen levels and manganese showed an inhibitory effect in this parameter. Aflatoxin and manganese caused increases in serum cholesterol and together the two compounds interacted synergistically.

A HABITAT EVALUATION SYSTEM DEVELOPED FOR THE EASTERN WILD TURKEY. P. R. Johansen; A. R. Tipton*, J. B. Whelan* Dept. of Fisheries and Wildlife, Va. Polytechnic Inst., Blacksburg, Va. 24061

A system is described which quantitatively evaluates potential habitat suitability for the eastern wild turkey in the Piedmont and coastal plain regions of southeastern United States. The procedure utilizes quantitative data on both macro and micro-habitat parameters which are considered critical for the survival, growth, and reproduction of the eastern wild turkey. These key environmental parameters include: availability of roosting sites, diversity of tree species, competition for food resources, proximity to water, proximity to forest clearings, mast availability, and degree of interspersion of cover types. An algorithm has been developed using these factors to calculate habitat suitability. Habitat parameters, considered essential for the evaluation, are assigned a weighted value reflecting the relative importance of that factor to the eastern wild turkey. In addition, each habitat parameter is subdivided into categories of intensity and assigned relative values, corresponding to the actual habitat condition recorded in the forest inventory. The appropriate intensity values are multiplied by their respective importance values for each habitat parameter. These products are then summed to produce an overall habitat rating for each area under investigation.

MENINGOENCEPHALITIS IN MICE FOLLOWING INTRAVENOUS INOCULATION WITH NAEGLERIA FOWLERI. D. T. John. Dept. Microbiol., Va. Commonwealth Univ., Richmond, VA 23298.
    The natural route of infection for Naegleria fowleri is by way of intranasal (IN) invasion. Nonetheless, mice can be killed by N. fowleri introduced through various other routes of inoculation. This report describes the histopathologic changes and eventual fatal meningoencephalitis for mice inoculated intravenously (IV) with N. fowleri. Male DUB/ICR mice weighing 13-18 g were inoculated IV with 2.4 x 10^6 LEE strain N. fowleri (LO_{50} dose). H & E-stained tissue sections were prepared on days 1, 3, 5, 8, 12, 16 and 21 after inoculation. The disease was characterized by amebic invasion of the brain, hemorrhagic necrosis, edema, and meningeal and perivascular leukocytic infiltration. An initial mononuclear cell response gave way to a polymorphonuclear leukocytic infiltrate in areas of necrosis. Although amebae were detected in tissues other than brain, pathologic involvement of these tissues was minimal. Mice inoculated IV with N. fowleri died from meningoencephalitis in the same way as mice inoculated IN.

DISTURBANCES OF SEROTONIN SYNTHESIS IN MICE ACUTELY DEPRIVED OF TRYPTOPHAN. M. Jones*, B. Weekley, and D. Kimbrough. Dept. of Biology, Va. Commonwealth Univ., and Dept. of Physiology, Med. Col. of Va., Richmond, Va. 23219
    The effect of dietary tryptophan (TRP) on brain and duodenal serotonin (5-HT) synthesis rates, liver protein levels, blood TRP, albumin and free fatty acids was investigated. Brain 5-HT synthesis was depressed in tryptophan deprived (TD) mice while duodenal 5-HT synthesis was enhanced. Liver protein was initially depressed in TD mice but increased following a tryptophan load. Blood tryptophan and albumin was depressed in TD mice while free fatty acids were not significantly different. Our results suggest (1) that tissue 5-HT synthesis rates and protein levels are altered in tryptophan deprived mice and (2) that the duodenum and liver may liberate TRP during periods of TRP deficiency to maintain blood and brain TRP levels.

THE DISPERSION OF HATCHERY-REARED RAINBOW TROUT STOCKED IN A VIRGINIA MOUNTAIN STREAM. W. T. Kendall*, and L. A. Helfrich*. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and St. Univ., Blacksburg, VA 24061
    Dispersal patterns of 578 tagged rainbow trout stocked into pool and riffle habitats of Big Stony Creek, Giles County, Virginia, were determined from voluntary tag returns and a creel census of fishermen during the 1979-80 trout fishing season. Twenty-two percent of the trout remained within the original 30 meter stocking location; 45% of the trout moved downstream while 33% moved upstream. Trout moving downstream traveled significantly further (p=0.001) than those trout moving upstream. Fifty percent of the marked fish were caught within 240 meters of the stocking location. There was no significant difference (p=0.1362) between the median distance moved of trout stocked in pools and those stocked in riffles.
    Three major physical factors (residence time, stream temperatures and stream flow rates) were found to strongly influence stocked trout dispersion. The distance trout moved was directly correlated (r=0.501, p<0.0002) with the amount of time in the stream. During stream conditions of low water temperatures and high flow rates, trout dispersion increased. Angling pressure did not affect (p=0.3264) the movement of hatchery-reared rainbow trout.

TISSUE LEAD CONCENTRATIONS AND BLOOD CHARACTERISTICS OF ROCK DOVES. Ronald J. Kendall*, W. B. Morehead*, J. T. Jones* and P. F. Scanlon, Dept of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

    Bone and liver lead concentrations (μg/g, d.w.) were determined by atomic absorption sepctrophotometry in 39 rock doves (Columba livia) collected from Blacksburg, Virginia. The blood enzyme, delta-aminolevulinic acid dehydratase (ALAD) was measured in each rock dove. Regression analyses (r^2 = 0.69) indicated that ALAD activity decreased as liver lead concentrations increased (log liver lead = 1.76 - 0.013X). Overall mean (±S.E.) liver lead concentrations was 2.11±0.41 g/g (range of 0 - 11.2 μg/g). Overall mean (±S.E.) bone lead concentration was 103.06±25.02 μg/g (range 6.63 - 727.86 μg/g) suggesting elevated lead exposure in this species, probably related to chronic low-level lead ingestion of contamination of grit particles obtained from roadsides. The rock dove appears to be a useful species for monitoring lead contamination of urban areas. ALAD activity measurements of blood samples collected from live birds or assaying of lead concentrations in bone and liver appear to the appropriate characteristics for monitoring purposes.

LEAD CONCENTRATIONS IN RUFFED GROUSE COLLECTED FROM SOUTHWESTERN VIRGINIA. R. J. Kendall*, G. R. Morman*, and P. F. Scanlon. Dept of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, VA. 24061.

    Lead concentrations(μg/g, d. w.) were determined by atomic absorption spectrophotometry in the livers and tarsometatarsus bones of 16 ruffed grouse (Bonassa umbellus) collected from southwestern Virginia. Overall mean (±S.E.) lead concentrations in tarsometatarsus bones was 2.78±0.57 μg/g and values ranged from 0.44 -9.19 μg/g. In the livers, there was a mean (±S.E.) lead concentration of 2.27±0.43 μg/g and values ranged from 0.36 - 6.83 μg/g. Liver lead concentrations provide an index of acute, high exposure to lead and in the grouse studied did not indicate high lead ingestion. No evidence of ingested lead shot was found in the grouse. Lead concentrations in bones of ruffed grouse were generally low and probably reflected only limited exposure to lead. Ruffed grouse appear to be suitable monitors of the relatively isolated ecosystems they inhabit in southwestern Virginia.

SUBUNIT STRUCTURE OF HEMOCYANIN FROM THE CRAB, CALLINECTES SAPIDUS. William K. Latham* and James E. Dendinger. Dept. of Biology, James Madison Univ., Harrisonburg, Va. 22807

    Crab hemolymph was electrophoresed on polyacrylamide gel at pH 8.3 and stained for protein with Coomassie blue. Four minor bands were evident at the cathodal end of the gel: two diffuse bands in the mid-portion and three major bands with two minor bands at the anodal end. Electrophoresis of lypholized hemocyanin resulted in the disappearance of the two middle bands and intensified staining of the three major anodal bands.
    Gel filtration of hemocyanin on a calibrated Sephacryl S-300 column at physiological pH yielded two protein peaks which had apparent molecular weights of 670,000 and 450,000 daltons. Each of these proteins were treated with a low ionic strength buffer at pH 10 containing EDTA to chelate divalent cations, and subsequently re-chromatographed. The first protein dissociated into what appears to be a single homogeneous particle with an apparent molecular weight of 67,000 daltons. When the 450,000-dalton protein was re-chromatographed at these conditions, it yielded two particles. One was an aggregate with an apparent molecular weight of 940,000 daltons and the other appeared to be a homogeneous particle with an apparent molecular weight of 65,000 daltons.

DAILY ACTIVITY RHYTHMS IN SYNAPTOMYS COOPERI AND MICROTUS PENNSYLVANICUS. A. Linzey. Dept. of Biology, Va. Polytechnic Inst., Blacksburg, Va. 24061
The lemming mouse (Synaptomys cooperi) and the meadow vole (Microtus pennsylvanicus) frequently co-exist in the same habitats. Field data indicate that the two species differ in their daily activity rhythms, with Synaptomys exhibiting a greater degree of nocturnality. Of 335 trap-captures of Microtus, 156 (47%) were during the nocturnal (includes crepuscular) time period, while 179 (53%) occurred during the day. Synaptomys were trapped 49 times, 40 of which were nocturnal captures (82%). On a seasonal basis, Microtus demonstrated considerable variability, with the percentage of nocturnal captures ranging from 22%-62%. This species expressed the highest degree of nocturnality between July and September (63%) and the lowest degree between October and December (22%). Synaptomys exhibited little seasonal variability, with the percentage of nocturnal captures ranging from 75%-100%.
Laboratory assessment of activity patterns involved quantification of wheel-running behavior under 16L8D at 18°C. Results generally confirmed field observations, with Synaptomys averaging about 80% of activity during hours of darkness as compared with about 55% for Microtus. While Synaptomys exhibited a single major activity peak during darkness, Microtus tended toward bimodality during this time frame.

INFLUENCE OF LEAD INGESTION ON REPRODUCTIVE CHARACTERISTICS OF MALE JAPANESE QUAIL. Susan M. Muth, Patrick F. Scanlon, Wanda B. Morehead and Francis C. Gwazdauskas. Dept. Fisheries and Wildlife Sci., Va. Polytechnic Inst. and State Univ. Blacksburg, VA. 24061.

Ninety adult male Japanese quail (Coturnix japonica) were assigned to treatments in a 2 x 3 factorial experiment with food intake (ad libitum or restricted to 15g daily) and lead dosing (0; 40 µg/g body weight weekly, 80 µg/g body weight weekly) as factors. Lead was given by intubation on days 1, 7 and 14. Body weights and foam gland dimensions were taken on Day 1 and again on Day 21 when birds were killed. At this time testes weights, liver weights and blood serum samples for testosterone assay were taken. Testosterone was assayed by radio-immunoassay. Body weights tended to decrease in lead treated birds and was greater in food restricted birds. Foam gland measurements tended to decrease to a greater extent in food restricted birds. Testes weights and liver weights appeared unaffected by lead treatments and food restriction. Testosterone values appeared variable and did not follow a readily discernable pattern.

EARLY LIFE HISTORY OF ALEWIFE (ALOSA PSEUDOHARENGUS) IN A VIRGINIA RESERVOIR. A. A. Nigro* and J. J. Ney. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.
Anadromous alewife are being widely introduced in south-eastern reservoirs as a forage species. One of the first such populations was established in Claytor Lake, a main-stream impoundment in western Virginia. Study of this population a decade after establishment characterized its reproduction, early growth and food habits. Spawning occurs from May through July in shallow bays over sand. Larvae feed almost exclusively on zooplankton and, like adults, are extremely size-selective. By 85 mm, larval food habits are indistinguishable from adults (150-225 mm).
Due to their rapid growth, alewife are limited as prey for sport fish to young-of-the-year. The extended spawning season assures an accessible alewife forage base throughout the growing season.

SEASONAL CHANGES IN BODY AND WING FAT CONTENT OF RUFFED GROUSE IN SOUTHWEST VIRGINIA. G. W. Norman*, and R. L. Kirkpatrick. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.
Either nine or ten ruffed grouse (Bonasa umbellus) were collected in each of the four seasons in southwest Virginia and analyzed for fat composition in evaluation of nutritional status. The feathers, head, feet, major organs and intestines were removed. Mesentery fat was separated from the intestines and returned to the body cavity. Wings were removed at the humerus-scapula-coracoid junction. Carcasses and wings were homogenized and then lyophilized for approximately 96 hours. Ground carcasses and wings were analyzed for crude fat in a soxhlet apparatus for 18 hours. Mean fat content ($\pm$SE) of the carcasses increased from summer (4.3+0.1%) to the fall (12.9+1.3%) and peaked in the winter (16.4+1.6%). Mean fat content dropped sharply from the winter to the spring (4.8+0.3%). Wing fat content was significantly correlated (r=0.75, P<0.0001) to that of the body fat in all seasons. Correlations between carcass and wing fat for each season were: summer r=0.68(P<0.029); fall r=0.89(P<0.001); winter r=0.86(P<0.002) and spring r=0.82(P<0.006). The transition period from winter to spring is hypothesized to be the more nutritionally stressful season of the year for ruffed grouse in southwest Virginia.

SEASONAL VARIATION IN SERUM TRIIODOTHYRONINE (T3) AND THYROXINE (T4) CONCENTRATIONS OF ADULT MALE WHITE-TAILED DEER. Anne Oelschlaeger, Robert J. Warren, Patrick F. Scanlon, Roy L. Kirkpatrick and Francis C. Gwazdauskas. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State University, Blacksburg, VA. 24061

Seven male white-tailed deer Odocoileus virginianus, age 2 years, were placed on a one-year experiment starting in March, 1978. Deer were randomly assigned to individual pens and treatment (diet) groups, either ad libitum consumption or restricted (75% of the average consumption of the ad libitum group). At 28-day intervals deer were immobilized with xylazine hydrochloride and bled by jugular venipuncture on 13 sampling days during the year. Hormone values were determined by radioimmunoassy of blood serum. Serum T4 for all animals was highest (P<0.05) in May (205±25 ng/ml) and July (208±14 ng/ml), and lowest in November (136±22 ng/ml). Serum T3 was highest from May-August (range, 2.11±0.13 to 2.44±0.12 ng/ml), and lowest in November (0.90±0.09 ng/ml). Changes in hormone concentrations reflected similar changes in body weight and feed consumption over the year. (Supported by the John Lee Pratt Animal Nutrition Foundation)

DIURNAL VARIATIONS IN TRIIODOTHYRONINE (T3) AND THYROXINE (T4) IN WHITE-TAILED DEER. Anne Oelschlaeger, David F. Gibson, Patrick F. Scanlon, Roy L. Kirpatrick and F. C. Gwazdauskas. Dept. Fisheries and Wildlife Sciences. Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061

A 2 year old male white-tailed deer Odocoileus virginianus, was fitted with a juglar cathether and bled every 2 hours during four 24-hour periods at intervals of 2 weeks to ascertain the periodicity of thyroid hormone concentrations in blood serum. Radioimmunoassy techniques were employed to determine the circulating concentrations of triiodothyronine (T3) and thyroxine (T4). Mean (±S.E.) serum concentrations were calculated by 2-hour period over the 4 sampling sessions. Data were variable, but an overall pattern was apparent. Visual examination of plotted values revealed that the temporal fluxes in circulating concentrations of the two hormones were similar. Nadir values for both T3 (1.27±0.18 ng/ml) and T4 (142±8 ng/ml) occurred at 1000 hours. The T3 concentrations appeared to fall to low values more steadily than did the T4. These results support the hypothesis of the existence of a diurnal pattern in circulating concentrations in thyroid hormones in this species. (Supported by a grant from the John Lee Pratt Animal Nutrition Foundation).

EFFECTS OF PHOTOPERIOD ON GROWTH AND DEVELOPMENT IN THE VOLE, MICROTUS PENNSYLVANICUS. D. H. Pistole* and J. A. Cranford. Dept. of Biolgy, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

Growth and development in $\underline{M}$. pennsylvanicus exposed to various photoperiodic treatments is shown to be significantly affected by photoperiod length. Young and subadults maintained under a long (18 h light per day) photoperiod gained weight more rapidly than those maintained under a short (6 h light per day) photoperiod. Body weight of $\underline{M}$. pennsylvanicus maintained under naturally occurring photoperiod and temperatures appeared to fluctuate as a function of decreasing and increasing day length and as a function of age. Adults lost weight during fall and early winter while subadults gained weight until late fall with growth ceasing in early winter. All animals gained weight after the winter solstice in the coldest month of the experiment (January). Thyroid activity, as reflected by thyroxine levels (T_4 radioimmunoassay), I-125 conversion ratios, thyroidal uptake of injected I-125 and relative thyroid weights, is significantly lower in $\underline{M}$. pennsylvanicus maintained under a short (6 h light per day) photoperiod than in those maintained under a long (18 h light per day) photoperiod.

HEAVY METAL CONCENTRATIONS IN FEATHERS OF RUFFED GROUSE FROM VIRGINIA. Patrick F. Scanlon, Richard G. Oderwald, Timothy J. Dietrick and Joe L. Coggin. Dept. Fisheries and Wildlife Sci., Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

Concentrations of lead (Pb), cadmium (Cd), nickel (Ni), zinc (Zn), Copper (Cu), and Silver (Ag) were determined by atomic absorption spectrophotometry in feathers of 130 ruffed gouse (Bonassa umbellus) shot by hunters in Virginia in 1977-78 and 1978-79 seasons. Mean concentrations (μg/g d.w.) of elements were compared between sexes, ages (adults vs juvenile) and seasons of collection.

Overall means ($\pm$SE) for each element were as follows: Cd, 0.74 ± 0.69; Pb, 6.38 ± 1.91; Ni, 0.05 ± 0.03; Zn, 93.88 ± 0.69; Cu, 4.15 ± 0.20; and Ag concentrations were all below detection limits of 0.1μg/mL. There were no significant ($P<0.05$) differences between sexes and age categories in any of the elements. A significant difference ($P<0.05$) between years was noted in Pb.

BLACK SUPPRESSOR MUTATIONS OF DROSOPHILA MELANOGASTER. A. F. Sherald. Dept. of Biology, George Mason Univ. Fairfax, Va. 22030

The second chromosome mutation black is characterized by a deficiency in β-alanine synthesis (Hodgetts, 1972, J. Insect Physiol. 18:937-947) which produces an interesting temporal, phenotypic dichotomy; abnormally light pupa cases and darkly pigmented adults. The mechanism of β-alanine involvement in these phenes has yet to be defined and a number of models have been proposed (Sherald, 1980, Experientia. 36:143-146).

A screen of over 80,000 chromosomes has yielded 5 X-linked mutations which suppress both the adult and pupal phenotypes of black. All 5 mutations are recessive, and complementation tests reveal that they are alleles. Intracistronic complementation at the locus indicates that the wild allele produces a protein product and that this intergenic suppression is not the result of an altered t-RNA structural gene. Two of the mutations have been tested and found to suppress an independently isolated allele of black. However, they do not suppress ebony; a mutation with phenotypes analogous to black caused by a deficiency in cuticular uptake of β-alanine (Jacobs and Brubaker, 1963, Science 139:1282-1283). These data suggest that the suppressors act by restoring normal levels of β-alanine synthesis.

Preliminary mapping of the locus has placed it at the tip of the X very close to scute.

LEAD CONCENTRATIONS IN MARYLAND WATERFOWL WITH AND WITHOUT INGESTED LEAD SHOT. Patrick F. Scanlon, Vernon D. Stotts, Richard G. Oderwald, Timothy J. Dietrick and Ronald J. Kendall. Dept. Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061

Livers were recovered from 613 individuals of 14 waterfowl species shot by Maryland hunters and lead concentrations were determined by atomic absorptions spetrophotometry. Individual birds were examined for presence of lead shot in gizzards by means of a fluoroscope and designated "positive" if lead shot were present and "negative" if lead shot were absent. Data were compared within species by Wilcoxon rank sum tests between lead shot positive and lead shot negative birds. Mean lead concentrations (μg/g d.w.) were significantly ($P<0.001$) higher in Branta canadensis (32.1 ± 9.0 vs 5.0 ± 0.5), Anas platyrhynchos (43.2 ± 12.8 vs 8.0 ± 1.6) and Anas rubipes (36.8 ± 13.5 vs 11.4 ± 4.7) which had ingested lead shot. Only 4 individuals of 11 other species were found to have ingested lead shot. Mean lead concentrations in other species without ingested lead shot were in the range 5.4 ± 1.4 μg/g d.w. in Bucephala albeola to 45.9 ± 40.4 μg/g in Anas acuta.

THE USE OF ISOLATED LEAF CELLS AND PROTOPLASTS AS TOOLS FOR INVESTIGATING PHOTOSYNTHESIS. J. C. Servaites*. Dept. of Biology, VPI&SU, Blacksburg, VA 24061

Mesophyll cells and protoplasts (cells without cell walls) can be isolated from leaves of a number of species using macerating and cellulytic enzymes. Gentle rupture of the plasmalemma of protoplasts results in the liberation of intact chloroplasts into the break medium. Rapid purification of these chloroplasts is afforded by centrifugation of the chloroplasts through a solution of colloidal silica. Both preparations of cells and chloroplasts have initially the same high rates of photosynthesis, but cells can maintain these rates of photosynthesis for hours and even days, whereas chloroplasts maintain these rates for only a few minutes. The radioactive products of cells after photosynthesis in an atmosphere of $^{14}CO_2$ are much more diverse than in isolated chloroplasts indicating that cells also carry on other metabolic activities (mitochondrial respiration, photorespiration, protein synthesis, etc.) which utilize and metabolize the products of photosynthesis. Inhibition of photorespiration and mitochondrial respiration with chemical inhibitors inhibits photosynthesis in cells, but not photosynthesis of isolated chloroplasts indicating that some pathways of cellular metabolism may be required to maintain chloroplast photosynthesis. Studies of the inhibition of the photorespiratory cycle indicate that under atmospheric CO_2 and O_2 concentrations as much as 50% of the carbon fixed in photosynthesis may enter this pathway.

OCCURRENCE OF KEPONE IN WHITE-FOOTED MICE (PEROMYSCUS LEUCOPUS NOVEBORACENSIS) ON JAMESTOWN ISLAND, VIRGINIA. C. Richard Terman. Laboratory of Endocrinology and Population Ecology, Biology Department, College of William and Mary, Williamsburg, Va. 23185 and Robert J. Huggett, Virginia Institute of Marine Science, Gloucester Point, Va. 23062

Significant quantities of Kepone were found in the livers of white-footed mice captured on Jamestown Island, Virginia in the James River. Levels of Kepone were significantly greater than found in the livers of mice of the same species from inland populations captured on the Ecological Study Area of the College of William and Mary, Williamsburg, Virginia adjacent to a tributary of the James River but at a distance of approximately 4.8 Km from the river. These data are the first indicating Kepone contamination of small mammals in a terrestrial ecosystem.

EFFECTS OF ESTRADIOL BENZOATE ON THYROID FUNCTION IN ADULT FEMALE RATS. T. W. Toney, S. M. Ashe*, and L. G. Martin. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

Because of the relatively high frequency of thyroid disorders that have been demonstrated empirically to occur in women at menopause, a great deal of research has been done investigating the possible relationships between thyroid function and female sex hormones. We examined the effects of various dose levels of estradiol benzoate on thyroid weight and I^{125} uptake in several groups of rats. Each group consisted of approximately 10 rats and was maintained on its particular treatment for 16 weeks. It was found that the weight of the gland was largest in ovariectomized rats receiving 40.0 ug. of estradiol daily, 10 times the normal replacement level. I^{125} uptake, however, was highest in rats receiving 4.0 ug. of estradiol daily, the normal replacement level. The lowest level of I^{125} uptake was seen in rats that had been ovariectomized and hypophysectomized. If rats in this condition were also treated with 4.0 ug. of estradiol daily, their uptake levels increased significantly, though still not as high as the rats with intact pituitaries receiving 4.0 ug. of estradiol. The results seem to indicate that estradiol does stimulate thyroid function by both direct stimulation of the thyroid gland and by increasing TSH secretion from the pituitary. (Supported by Faculty-Grant-in-Aid #1-93035 awarded to Loren G. Martin, Va. Commonwealth Univ.)

THE EFFECTS OF GOLD THIO GLUCOSE ON TRYPTOPHAN AND TYROSINE METABOLISM IN RATS. B. Weekley and M. Jones* Dept. of Physiology, Med. Col. of Va., Richmond, Va. 23219 and Dept of Biology, Va. Commonwealth Univ., Richmond, Va. 23219

The effect of gold thioglucose on hepatic and cerebral metabolism of tryptophan (TRP) and tyrosine (TYR) was investigated. Gold thioglucose treatments were given to destroy the ventromedial hypothalamus (VMH) or sympathetic center in rats. To observe both the neural (VIA the sympathetic ganglia) and endocrine (VIA the hypothalamic-pituitary axis), acute and chronic treatments were used respectively. The results suggest that hepatic tyrosine aminotransferase (TAT) is under hypothalamic neural control while tryptophan 2, 3 dioxygenase is under endocrine control secondary to adrenal steroids. Cerebral activity of tryptophan 5 hydroxylase and TAT are acutely depressed following gold thioglucose treatment while the chronic response is much less marked.

MID-WINTER HEMATOPOIESIS IN WATER SNAKES (GENUS:NATRIX). William H. Yongue, Jr., Dept. of Biology, VPI&SU. Blacksburg, VA 24061.

As an aspect in the continued investigation of reptilian hematology, blood smears were made monthly of eight natri during the period December to May to re-evaluate earlier studies which suggested that this period is one of limited hematopoietic activity. The presence of blastoid, dividing, immature and thrombocytic cells in the peripheral circulation was the parameter for hematopoiesis. All of the natri had been previously challenged with cytotoddia (=Toddia:Protozoa) and six of them had been positive for varying periods while two (Sip 21 and Sip 35) were refractory. None were cytotoddial patent during this study period nor had been since March of the year earlier. During the peak of hematopoiesis (June-August and Post-Ecdysis) the hematopoietic cells reach more than 50% of the total cells. During this study period 26% was the highest reached. Four of the snakes had their lowest number of hematopoietic cells in December, 3 in January and 1 in February. Five of the 8 natri shedded during the period; 2 shedded twice. Post-ecdysis was characterized by increased hematopoietic cells but never above 35% of total cells. This work supported the earlier observations and it represents the first report of hematopoiesis in snakes with known cytotoddial histories.

AGGREGATION BEHAVIOR IN THE LARGE MILKWEED BUG, ONCOPELTUS FASCIATUS, AND SMALL MILKWEED BUG, LYGAEUS KALMII (HEMIPTERA LYGAEIDAE). S. T. Trumbo* and N. J. Fashing. Dept. of Biology, Col. of William and Mary, Williamsburg, VA 23185.

It has been reported in the literature that only immature and young adult Oncopletus fasciatus aggregate, and that this behavior is due to an aggregation pheromone. It is also reported that Lygaeus kalmii has no aggregation pheromone, and that any aggregations observed in this species were probably due to mutual attraction to abiotic factors, not an attraction to one another. We tested for aggregation behavior in the laboratory using both species of bug, and taking care to control for any abiotic factors which might influence aggregation behavior. Significant aggregation behavior was demonstrated in both immatures and adults of both species, as well as in young and old adults. Aggregations in both species were found to increase in size with time.

The influence of olfaction via the antennae and of vision on aggregation behavior were tested using O. fasciatus. Olfaction was found to be of primary importance, and vision may play a secondary role. Also utilizing O. fasciatus, an inverse relationship was found between temperature and the tendency to aggregate, and there is some evidence that more aggregation occurs in the dark than in the light.

THE OCCURRENCE OF SPERM ANTIBODIES IN BLOOD SERA AS DETECTED BY THE KIBRICK, FRANKLIN-DUKES AND ISOJIMA TESTS. J. W. E. Wortham, Dept. of Biological Sciences, Old Dominion University, A. A. Acosta, Dept. of Obstetrics & Gynecology, Eastern Virginia Medical Center, R. J. Swanson, S. B. Ackerman and Kay Taylor*, Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

Blood serum of suspected infertile couples was tested for the presence of antisperm antibodies. Serum from 11 of the individuals (7.3%) tested were positive for either the Isojima test, Franklin-Dukes test, or Kibrick test and six individuals were positive for more than one test. Nine of the males and 2 of the females contained antisperm antibodies in their blood serum. Sperm immobilizing antibodies detected by the Isojima test were found in 2 males and 1 female. Sperm agglutinating antibodies detected by the Franklin-Dukes and/or Kibrick test were present in 8 males and 1 female. Five of these males were positive for both the Kibrick and Franklin-Dukes tests. Basic semen parameters (e.g., morphology, motility, count, viability) were compared between the antisperm positive males and antisperm negative males.

FISH HOSTS OF THE GLOCHIDIA OF FOUR LAMPSILID MUSSELS IN BIG MOCCASIN CREEK, VIRGINIA. Alexander V. Zale and Richard J. Neves. Dept. of Fisheries and Wildlife Sciences, VA Polytechnic Inst. and State Univ., Blacksburg, VA 24061

The reproductive biology of most freshwater mussels is unknown, particularly the required fish hosts for glochidial metamorphosis. Fish hosts of the four lampsilid mussel species in Big Moccasin Creek, Virginia were identified by induced laboratory infections and verified through field observations and collections. Medionidus conradicus infected the fantail darter (Etheostoma flabellare) and the red-line darter (E. rufilineatum). Micromya nebulosa was hosted by the smallmouth bass (Micropterus dolomieui) and the rock bass (Ambloplites rupestris) while Micromya vanuxemensis parasitized the banded sculpin (Cottus carolinae). Lampsilis fasciola infected the smallmouth bass. These results indicate that non-game fish species play an essential role in the life cycle of some lampsilid mussels. River systems inhabited by species of endangered mussels must therefore be managed to retain their original piscine fauna, at least until appropriate fish hosts for successful reproduction are identified.

Botany

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NOMENCLATURAL PROBLEMS IN THE PLANT FAMILY MYRICACEAE. J. Rex Baird, Biology Department, Clinch Valley College of the University of Virginia, Wise, Virginia 24293.

The family Myricaceae has been variously regarded as consisting of one or two, or three genera, all of which are represented in the North American flora. Results of recent investigations, including comparative studies of floral and vegetative morphology, support the recognition of three genera, but a study of the nomenclatural history reveals some misapplications of generic names that may necessitate numerous name changes. Studies of the eight species present in North America (north of Mexico) show that several nomenclatural mistakes at the species level have been perpetuated in many major manuals.

AN INTERPHYSIOGRAPHIC ANALYSIS OF HERB AND SHRUB VEGETATION OF VIRGINIA FORESTS. S. J. Binns. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

Thirty upland deciduous stands were sampled from the mid-Coastal Plain to the mid-Piedmont in New Kent, Hanover, and Louisa Counties. Density data for herbs and shrubs was collected, and soil samples were collected in each stand. A cluster analysis of the vegetation data was performed using Euclidean distance and "furthest neighbor" clustering. Four clusters of stands were identified. A cluster of six stands with Euonymus americanus as the dominant species was strongly related to the Coastal Plain, but the other clusters were not physiographically associated. Other dominant species in the analysis were Vaccinium vacillans, Gaylussacia baccata, and Mitchella repens.

The soil nutrients most strongly correlated with the dominant species were calcium and magnesium. E. americanus and associated species were positively correlated with these nutrients and the ericaceous shrubs were negatively correlated.

VEGETATION/ELEVATION RELATIONSHIPS IN THE MARSH/UPLAND TRANSITION ZONE OF THE CENTRAL ATLANTIC COAST. John D. Boon III, Donna M.E. Ware, and Gene M. Silberhorn, Va. Inst. of Marine Sci. & Dept. of Biol., Coll. of Wm. & Mary. 23185.

Transects were run across the transition at each of five primary sites (one each in s.NC, n.NC, VA, MD, and DL), plus satellite secondary sites. Coverage was estimated for herbaceous plants and basal area was calculated for woody plants. Elevational measurements were taken along each transect and adjusted to refer to the tidal datum of MHW established by the National Ocean Survey. The combined vascular flora for the transition totalled 85 species. About 2/5 of these were vegetationally significant and included species of the adjacent woodland, weedy heliophilic upland species, and marsh species. Distichlis spicata, Spartina patens, Juncus roemerianus, or Baccharis halimifolia marked the upper limit of the transition most frequently. These (except Juncus), plus Rhus radicans, Panicum virgatum, and Iva frutescens occurred in the transition in all five study regions. In the transition (a) herbaceous plants dominate, the marsh plants reaching their upper limit either just below the woodland or within its edge, or (b) Baccharis forms a shrub border continguous to the woodland, or (c) admixture of herbaceous plants and Baccharis and/or Iva frutescens occurs.

An elevation for the upper limit of the transition of ca. 40 cm above MHW was typical of the tidally-restricted coastal sound environment, 60-70 cm for tidally open marsh/lagoon environments, and 34 cm for the bay-estuarine environment.

FURTHER ADDITIONS TO THE FLORA OF NORTHERN VIRGINIA. T. R. Bradley. Dept. of Biology, George Mason Univ., Fairfax, Va. 22030

Recent collections from northern Virginia have produced many county records of which a few are also state records. Apparently collected for the first time from Virginia are Ludwigia uruguayensis (Camb.) H. Hara (Onagraceae), Cornus stolonifera Michaux (Cornaceae) and Tribulus terrestris L. (Zygophyllaceae). Also new to the state is Sida hermaphrodita (L.) Rusby (Malvaceae) which was previously misidentified as Napaea dioica L., which must now be removed from the Virginia flora. A rare second collection of Verbena bracteata Lag. and Rodr. (Verbenaceae) from Hog Island is the first collection since originally found in Southampton County in 1893. Also a second location for Amaranthus lividus L. (Amaranthaceae) was discovered in Northampton County. Range extensions of interest are Parapholis incurva (L.) C. E. Hubbard (Poaceae), the first collection west of the Chesapeake Bay, and Ludwigia leptocarpa (Nuttall) H. Hara from Fairfax County which is about 55 kilometers up the Potomac River from King George County where it was found in 1978.

PHYTOCHROME CONTROL OF ROOT GROWTH RATE IN LEMNA SPP.
G. P. Chamuris[*] and P.T. Nielsen. Dept. of Biology, James
Madison University, Harrisonburg, VA 22807

Three strains of Lemna (L. gibba L., strains G1 and G3;
and L. minor L.) were studied in order to confirm and extend
an earlier report that root growth in L. gibba G1 and L.
gibba G3 is under phytochrome control. Plants were cultured
in inorganic growth medium, and were exposed to several low
energy light treatment conditions: no treatment (control),
5 min R, 5 min R + 15 min FR, and 5 min R + 15 min FR + 5 min
R. These treatments immediately preceded the 14 hr period of
darkness. Root lengths were measured at 24, 28, 48, 52, 72
and 76 hrs; and root growth rates were calculated.

Comparison of root growth rates revealed that far-red
light treatments (R + FR) inhibited root growth rate. This
inhibition was abolished upon subsequent treatment with red
light (R + FR + R). This red/far-red photoreversibility
strongly suggests that root growth in Lemna spp. is under
phytochrome control.

A PRELIMINARY STUDY OF SOOTY MOLD GROWTH AND
ABUNDANCE NEAR A SMALL DISTILLERY IN RESTON, VA.
C. B. Cloyed* and A. P. Torzilli*. Dept. of
Biology, George Mason Univ., Fairfax, Va. 22030

Comparisons of growth and occurrence of the
predominant dematiaceous fungi were made between
distillery, adjacent and non-adjacent sampling
sites. To explore utilization of hydrocarbon
emissions from the whiskey aging warehouses,
additional samples were collected at all sites
on Czapek-Dox Agar with ethanol added as a sole
carbon source.

The predominant dark genera at all sites were
Cladosporium sp., Aureobasidium pullulans (de
Bary) Arnaud and Alternaria sp. Significant
differences in growth and frequency occurred,
particularly between distillery/adjacent sites
and non-adjacent sites. The three genera grew on
ethanol plates from all sites, again with signi-
ficant differences between sites. Abundant
growth on and near the whiskey aging warehouses
appears influenced by several environmental
factors, contributing to the utilization of
hydrocarbon vapors by the fungi present. (Aided
by EPA Fellowship U911186)

OBSERVATIONS OF PHYTOPLANKTON COMPOSITION ON THE SOUTH-
EASTERN CONTINENTAL SHELF. R. B. Fawley*, S. Cibik*, C. K.
Rutledge*, and H. G. Marshall. Depts. of Biological Sciences
and Oceanography, Old Dominion Univ., Norfolk, Va. 23508.

Surface water bottle samples from 36 stations were
collected in September 1978 over the U.S. southeastern con-
tinental shelf by the South Carolina Wildlife and Marine
Resources Department. Samples (500 ml) were preserved in 5%
buffered formalin and processed with a modified Utermohl
method utilizing an inverted plankton microscope.

The total number of species identified was 121 with the
major taxonomic groups composed of diatoms (87 species) and
dinoflagellates (28 species). Other groups represented
included the blue-green algae (5 species) and silicoflagel-
lates (4 species). The diatoms were the most abundant and
widely distributed group.

Oscillatoria erythraea occurred most frequently, being
present at 25 stations. The most abundant (# of cells/liter)
species were the diatoms Rhizosolenia alata f. indica and
Rhizosolenia alata, with Melosira granulata var. angustis-
sima, Leptocylindricus danicus, and Rhizosolenia alata f.
gracillima being present in lower concentrations. The most
abundant dinoflagellate was Prorocentrum micans. No other
dinoflagellate was present in significant concentrations.
It was noted that the blue-green algae Nostoc commune,
Oscillatoria erythraea and Johannesbaptista pellucida were
commonly found in the nearshore waters.

THE COMPOSITION AND CONCENTRATION OF PHYTOPLANKTON WITHIN
THE VIRGINIA BARRIER ISLAND COMPLEX. S. Cibik*, C. K.
Rutledge*, R. B. Fawley*, and H. G. Marshall. Dept. Biolo-
gical Sciences, Old Dominion Univ., Norfolk, Va. 23508.

Ten collections of surface phytoplankton were made at
eight stations between November 1978 and October 1979 within
the channels of the Virginia Barrier Island complex.

A total of 192 taxa were identified, consisting mainly
of north and south temperate neritic species. The samples
were dominated by nanoplankton sized diatoms, with various
dinophyceans, silicoflagellates, chlorophyceans, cyanophy-
ceans, and coccolithophores present in lesser numbers. The
seasonal phytoplankton composition within the channels was
similar to composition reported for the continental shelf
waters.

Three population maxima occurred in winter, spring, and
fall, with four peaks in species diversity noted. Concen-
trations of total phytoplankton ranged from 13,500 to 2.78
million cells/liter. Species diversity (Shannon's Index)
ranged from 2.35 to 4.05. Ubiquitous during the study were
Skeletonema costatum and Asterionella glacialis. Seasonal
assemblages of total phytoplankton were identified. The
Virginia Environmental Endowment is acknowledged for the
support of this study.

VASCULAR FLORA OF NATURAL TUNNEL STATE PARK,
SCOTT COUNTY, VIRGINIA. Richard V. Davis, Jr.*
Box 193, Coeburn, Virginia 24230.

Natural Tunnel is in the Ridge and Valley
province of extreme southwestern Virginia, an
area where little systematic collecting has
been done. Field work in the state park began
in February of 1978 and was concluded in August
of 1979. Data concerning anthesis, abundance,
and habitat type were noted for all taxa and
information on soil types, climate, and geological
structure was gathered. Ten vegetation types
were recognized on the basis of land use patterns
and environmental conditions. A total of 552
species of vascular plants was collected, estab-
lishing county records for 97 taxa and range
disjunctions for several species. The large
number of species reflected the diversity of
habitats. The range disjunctions and the number
of county records established emphasize the need
for further floristic study in southwestern
Virginia.

THE DISPERSAL OF SAMARAS ABOUT AN INDIVIDUAL OF BETULA UBER
(ASHE) FERN. UNDER NATURAL CONDITIONS. R. H. Ford*, T. L.
Sharik, and P. P. Feret. Dept. of Forestry, Va. Polytechnic
Inst., Blacksburg, Va. 24061

Samaras of a Betula uber individual in a forested stand
were collected during winter 1979-80 to determine maximum
dispersal distance and the temporal dispersal profile.
Sixty-four .25m^2 screen traps, each sampling equal areas,
were placed about the seed source along eight 100m long
radii of a 3.1 hectare circle. The traps were emptied week-
ly from mid-December until April. Seed fall was maximum
at 25m, decreased linearly from 25m to 66m, and leveled off
gradually thereafter. A strong directional component was
observed in the dispersal profile with 70% of the samaras
being collected in the SE quadrant of the study area. This
directional component may be caused by a prevailing NW wind.
Over 50% of the samaras were dispersed during January, with
a peak rate (34% of the total seedfall) occurring during the
week ending January 25. A second peak representing over 25%
of the total samaras was observed in mid-February. The
peaks were associated with periods of moderate to warm tem-
peratures.

NUTRIENT CONTENT OF LITTERFALL: A STUDY OF FOUR PLANT COMMUNITIES IN THE GREAT DISMAL SWAMP, VIRGINIA. Marta Gomez* and Frank P. Day, Jr., Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508.

The nutrient content of the litterfall in four plant communities in the Great Dismal Swamp, Virginia was studied. These stands differ in species composition and flooding regime. The elements analyzed were N, P, K, Mg and Ca. Leaf fall of plant species found at the cypress community exhibited a higher percent concentration of the nutrients analyzed except Ca. The cedar stand showed lower concentrations of the mobile elements in the leaf litterfall. Nutrient deposition was greatest in the maple-gum and cypress communities, which reflects the higher leaf fall rates at these two sites. Nutrient analysis of small woody litter was also conducted.

CHROMOSOMAL EVOLUTION IN THE GENUS ASTER (ASTERACEAE). L. Michael Hill. Department of Biology, Bridgewater Col., Bridgewater, VA 22812.

The purpose of this investigation is to consider the chromosome number of species of the genus Aster (Aster-aceae) in the Middle Atlantic United States. Although there is much chromosome data on Aster sp. from North America, it is lacking in species found in the Virginias and Carolinas. This report concerns the chromosome num-bers of Aster novae-angliae L., A. cordifolius L., A. pilosus Willd., A. linariifolius L., A. acuminatus Michx. and Aster oblongifolius Nutt. These data will be com-pared with reports from other sources and will be put within the context of chromosomal evolution of the Genus as a whole. Aster is known for its morphological com-plexity. The genus is also complex from a cytological point of view.

STUDIES IN THE VIRGINIA FLORA: PHRYMACEAE AND PLANTAGINACEAE. Miles F. Johnson. Department of Biology Virginia Commonwealth University, Richmond, VA 23284

Phrymaceae, a monotypic family, and Plantaginaceae with nine species in Virginia are studied floristically. A new key to Virginia Plantago, descriptions, ecologic data and distribution maps are presented.

Plantago wrightiana Done. is reported new to the flora and Plantago cordata Lamark is verified as present in the flora.

THE VASCULAR FLORA OF LITTLE STONEY CREEK, SCOTT COUNTY, VA. Dwight E. Peake*, Dept. of Biology, Col. of William and Mary, Williamsburg, VA 23185.

Little Stoney Creek is part of the Tennessee Valley drainage system and is in the extreme northwest corner of Scott County, Virginia. The stream is at the eastern edge of the Appalachian Plateau Province on Pennsylvania Age strata in the Cumberland Mountains. A section one-half mile wide on each side of the stream from Bark Camp Lake to Hanging Rock encompasses a study area of approximately 14 square miles within the Clinch Ranger District of the Jefferson National Forest. Collection of the vascular plants began in May, 1978 and continued until April, 1980. Major community types present in the study area are mixed deciduous woods, mixed deciduous-pine woods, lake and stream edge, and disturbed areas. A total of 480 species of 271 genera of 92 families has been collected and identified, and many are Scott County and Virginia Appalachian Plateau Province records. Some of the more interesting taxa include Isoetes engelmannii, Lygodium palmatum, Habenaria peramoena, Liparis loeselii, Callitriche heterophylla, Myriophyllum heterophyllum, Leucothoe axillaris var. editorum, Aster surculosus, Heterotheca nervosa var. nervosa, Helianthus atrorubens, and Liatris spicata.

A VEGETATIONAL ANALYSIS OF THE NORTHEASTERN NORTH CAROLINA OUTER BANK'S MARSHES, J. E. Perry* and F. P. Day, Jr. Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508.

Seasonal productivity and plant association similarities were measured for six brackish marsh sites in the North Carolina Outer Banks. Three randomly chosen 1/4 m² plots were clipped at ground level from each site on a biweekly interval and returned to the lab. Each sample was se-parated into species, oven dried and weighed. A total of 38 species was collected from the sites. Five plant as-sociations and three site groups were defined using a Czekanowski quantitative classification index. Sites 2, 3 and 6 formed group 1 dominated by a Juncus-Eleocharis association. Co-dominant associations of Spartina-Mikania and Juncus-Eleocharis were found in both sites 1 and 5 forming group 2. Group 3 consisted of site 4, an area re-cently exposed to dredge and fill activity.

CHARACTERIZATION OF PURDMYCIN DISSOCIATED MAIZE RIBOSOMES. W.C. Phelps, E. R. Stout, A. Esen. Dept. of Biology, V.P.I. and S.U., Blacksburg, VA. 24061

Over the past decade, prokaryotic and eukaryotic ribosomes have been the subject of extensive biochemical, biophysical, and functional characterization. However, comparative data from plant systems is sparse and surpising-ly variable. For example, the total number of cytoplasmic ribosomal proteins reported in plants varies from a low of 44 in barley to a high of 99 in peas. In view of the functional importance of ribosomes, such evolutionary variation is highly unlikely and is presumably due to experimental inadequacies.

An effective procedure for subunit isolation has been established that is based on cytoplasmic monomer dissocia-tion by puromycin/GTP pre-incubation and exposure to 250 mM KCl. The large 60S and small 40S subunits isolated were then characterized with respect to purity of preparation, structural integrity, and functional activity as measured by poly(U) directed in vitro translation. Ribosomal proteins were then extracted from each subunit and analyzed by a modification of the two-dimensional polyacrylamide gel electrophoretic procedure of O'Farrell.

OBSERVATIONS OF A DIAPORTHE-LIKE FUNGUS ON METROSIDEROS COLLINA. Martha K. Roane and F. R. Fosberg, Dept. of Plant Pathology & Physiology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061, and National Museum of Natural History, Smithsonian Institution, Washington, DC 20560.

Ohia, Metrosideros collina ssp. polymorpha, the principal indigenous forest tree of the Hawaiian islands, is also a pioneer species on new lava flows. Ohia decline, which has affected stands totalling about 100,000 acres, has been associated with nutrient deficiencies and Phytophthora root rot. However, we have found that a Diaporthe-like fungus fruits shortly after the trees die and produces carbonaceous stromata with one olive-green fertile layer containing perithecia and a second marbled olive-green and white interior layer extending as a foot into the host. Asco-spores are hyaline, one-celled, allantoid with one to several refringent globules. On malt agar, Phomopsis-like α and β conidia are produced in olive-green stromata with conidial locules opening through a pore. The pathogenicity of this fungus has not yet been determined.

AGE-STRUCTURAL RELATIONSHIPS IN AN APPALACHIAN OAK FOREST IN SOUTHWEST VIRGINIA. M. S. Ross*, T. L. Sharik, and D. W. Smith*. Dept. of Forestry, Va. Polytechnic Inst., Blacksburg, VA 24061.

The age structure of all tree species in seven Appal-achian oak stands in Southwestern Virginia was determined. Aging of small individuals was done by counting terminal bud scars or by counting rings in cores extracted with a micro-increment bore. Aging of large individuals involved counting rings on stumps immediately after the stands had been clearcut. Total age structure in all stands did not differ significantly, and had the following pattern: (1) A regular decrease in density with age in the 0-20 age classes, (2) A gap in the 20-40 year age classes in which density was relatively low, and (3) A series of density peaks in the 40-80 year age classes associated with exten-sive harvesting, frequent fire, and the demise of American chestnut. Differences in species behavior were not obvious, and generally adhered to the above pattern. Because of poor correlations found between diameter and age, it was suggested that diameter distributions give an imperfect picture of replacement processes in forests. (Aided by USFS and Va. Ag. Fndn.)

PHYTOPLANKTON BIOMASS ESTIMATES RELATED TO PRIMARY PRODUC-TIVITY VALUES. C. Rutledge*, R. Fawley*, S. Cibik*, K. Nesius, and H. Marshall. Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508.

The relationship between phytoplankton biomass parameters and primary productivity rates were assessed using multiple regression analysis. Phytoplankton samples taken at eight stations in December, 1978 were analyzed. Carbon fixation rates were determined using a standard ^{14}C method. The fol-lowing biomass estimates were calculated: a) protoplasmic volumes, b) cellular surface area, c) cellular volumes, d) metabolizing biovolumes, and e) number of cells/liter.

Regression analysis yielded a significant regression equation (α=.05) which contained only three of the above parameters. The equation was: $Y=4.78\cdot10^{-5}(X_1) + 1.59\cdot10^{-7}(X_2) - 2.35\cdot10^{-8}(X_3) + 5.60\cdot10^{-1}$. Where: Y = carbon fixed (mgC/m^2/hr), X_1 = number of cells/l, X_2 = Σ metabolizing biovolumes (μm^3/l), X_3 = Σ protoplasmic volumes (μm^3/l). The multiple R for the equation was 0.93 and the multiple R^2 was 0.86. Part correlation analysis indicates the indepen-dent variable X_1, explains 71.2% of the variance of the de-pendent variable. Stepwise inclusion of the remaining variables into the equation increased the explained variance by 9.23% and 5.26% for X_2 and X_3 respectively.

There existed a significant regression relationship be-tween primary production to 1) simple cell numbers/l and 2) volumetric parameters which were calculated to reflect more truly the metabolizing biomass in phytoplankton.

A FLORISTIC STUDY OF HOLOCENE LEAF MATS FROM MACON COUNTY, ALABAMA. Donna L. Shipp, Biology Dept., George Mason Univ. Fairfax, Va. 22030, and USGS, Reston, Va. 22092

Plant megafossils found in organic rich clay lenses a-long Uphapee Creek in Macon County, Alabama, have radio-carbon ages of 6200$^+$ 110 and 7500$^+$ 110 y.B.P. These carbonaceous lenses are contained in terrace deposits adjacent to and exposed along the length of Uphapee Creek. Generally the seeds and fruits are contained within lenses of sand whereas the leaves are in a matrix of clay. Leaves, fruits and seeds have been isolated and identified by comparing them to herbarium specimens. The leaf flora include Betula nigra, Quercus nigra, and Pinus sp. The seed and fruit fossils, together with the leaves, provide a complete picture of the flora present between 6200 and 7500 y.B.P. The fruits and seeds include specimens from Liriodendron tulipifera, Rhynchospora sp., and Carya sp. A floristic analysis on the paleoflora indicates an oak-hickory-pine forest. This same assemblage is representa-tive of Alabama forests today. If composition can be correlated with climate, then we can assume that today's climate is similar to that between 6200 and 7500 y.B.P.

CYCLOHEXIMIDE - AMENDED MEDIA FOR THE DIFFERENTIATION OF ENDOTHIA PARASITICA FROM E. GYROSA. R. J. Stipes and J. A. Daubert*. Dept. of Plant Path. and Physiol., Virginia Tech, Blacksburg, VA 24061.

The antifungal antibiotic, cycloheximide (Acti-dione®), produced by Streptomyces griseus, was used successfully as an agar medium amendment to differentiate Endothia parasitica from E. gyrosa. The compound was incorporated in a 0.5% glucose - 0.1% yeast extract - 1.5% agar at concentrations of 1, 2, 10, 25, 50 and 100 µg/ml. Plates were inoculated with 10 different specimen-vouchered isolates each of E. parasitica and E. gyrosa which varied in source and host. At 1 µg/ml, the percent growth inhibition of E. gyrosa ranged from 80-95%, while E. parasitica showed only moderate inhibition (6-25%). E. gyrosa did not grow at concentrations above 2 µg/ml, while E. parasitica had trace growth even at 50 µg/ml. Similar results were obtained with cycloheximide-amended potato-dextrose agar. This is the first report in which Endothia spp. have been differentiated chemotaxonomically with a fungitoxic xenobiotic compound.

VASCULAR FLORA OF MATHEWS COUNTY, VIRGINIA. Margaret van Montfrans*. Dept. of Biology, College of William and Mary, Williamsburg, Va. 23185

A floristic study was conducted from June, 1978 to Nov-ember, 1979 in Mathews County in Virginia's outer Coastal Plain. Mathews County, which covers an area of 105 sq. mi., is in the easternmost section of the Middle Peninsula, and is of predominantly low elevation. The area consists of such habitats as salt water and fresh marshes, swampwoods, mixed pine-deciduous woods, ravines and bluffs, and disturbed areas. A total of 640 species representing 372 genera of 114 families were identified; ten of these species are re-ported as new for the outer Coastal Plain, while 57 are records for the Middle Peninsula. New species for the county record totalled 463. Noteworthy plants collected include Salpichroa origanifolia, Eryngium prostratum, Euphorbia heterophylla, Tussilago farfara, Chelone cuthbertii, and Carya aquatica.

A vegetational analysis using the Bitterlich method of forest sampling was carried out at two sites in the county. At the forested bluffs site along the Piankatank River, Quercus prinus was the dominant species, with Q. velutina, Liquidambar styraciflua, and Q. alba next in order of rel-ative dominance. The second site, a swampwoods along North End Branch, revealed Acer rubrum dominant, followed by Liquidambar styraciflua, Carpinus caroliniana, and Carya aquatica.

A SYSTEMATIC SURVEY OF SELECTED GENERA OF THE TRIBE
HELIANTHEAE IN VIRGINIA. V. M. Terry*. Dept. of Biology,
Col. of William and Mary, Williamsburg, VA 23185
    This study is a systematic treatment of a portion of the
Heliantheae, which is considered to be the most primitive
tribe of the family Compositae (Asteraceae). Three of the
24 genera occurring in Virginia were examined: Borrichia
Adanson (1 sp.), Helianthus L. (20 sps.), and Verbesina L.
(3 sp.).
    Data was obtained from the examination and annotation of
over 1200 specimens from nine herbaria, from extensive
observations and collections made in the field, and from
the literature. Of those examined, 243 were collected
personally in the course of ten collecting trips taken in
the late summer and fall of 1979; 88 of the 98 counties of
Virginia were visited as a result of these extensive
excursions. Voucher specimens have been deposited in the
Herbarium of the College of William and Mary.
    In addition to a key to the genera selected for treat-
ment, keys to species, descriptions, ecological data, and
county-based distributional information have been provided.

DECLINE OF Pinus strobus L. ON LANDSCAPES IN VIRGINIA.
M. J. Weaver*, R. J. Stipes and D. F. Amos. Depts. Plant
Pathol/Physiol. and Agronomy, Va. Tech, Blacksburg, VA 24061
    A decline of Eastern white pine (Pinus strobus L.) has
been observed for a number of years in Virginia and across
the eastern U.S. Within the past 5 yrs, apparent increased
incidence of the disorder noted by homeowners, landscapers,
nurserymen, extension agents and others, plus the increased
costs of replacing these trees, have warranted an investi-
gation into the causal factors of the decline.
    A group of 100 test trees, ranging from healthy controls
to trees in various stages of decline, has been studied
intensively at various locations in Virginia. A systematic
disease indexing method was developed and followed for each
tree in the study. Data were collected on tree growth,
various chemical and physical soil factors, associated abio-
tic and biotic agents, and on rhizosphere and root zone
indicators.
    Results implicated the following interacting complex of
factors: high soil pH (7.0-8.5), heavy soil texture, high
amounts of competition and shading, root impedance, physi-
cally disturbed soil horizons, soil compaction, various
secondary biotic agents, and various other abiotic stresses,
primarily moisture stress and O_2 tension.
    Thus far, no one factor is suspected as being the primary
causal agent contributing to decline. Poor quality growing
sites, however, on which this sensitive species is planted,
appear to be involved in an overall and primary way.

VASCULAR FLORA OF THE BURWELL BAY AREA, ISLE OF
WIGHT COUNTY, VIRGINIA. L. L. Whitmarsh, Col. of
William and Mary, Williamsburg, Va. 23185
    The Burwell Bay area is a twenty square mile
area located in northeastern Isle of Wight County,
Virginia. This county is located in the Inner
Coastal Plain region of Virginia. Collections of
the vascular flora began in April of 1979 and con-
tinued until April of 1980, being conducted at
least once weekly throughout the growing season.
Voucher specimens have been deposited in the Her-
barium of the College of William and Mary.
    The major plant communities present include 1)
freshwater marshes 2) saltwater marshes 3) sand
and marl areas 4) bottomlands 5) pine-deciduous
woods 6) deciduous woods 7) recently disturbed
areas.
    A total of 559 species representing 340 genera
of 108 families have been recorded from the Bur-
well Bay area. Two hundred and twelve have not
previously been reported in the literature as
occuring in Isle of Wight County. Species of in-
terest include Eleocharis parvula, Corallorhiza
odontorhiza, Monotropa hypopithys, Viburnum acer-
ifolium, Erigeron bonariensis, and Senecio vul-
garis.

RECENT INCREASE IN THE ABUNDANCE OF RED CEDAR JUNIPERUS
VIRGINIANA L.) IN VIRGINIA EAST OF THE BLUE RIDGE. E. Spenc-
er Wise, Dept. of Biology and Environmental Science,
Christopher Newport Col, Newport News, Va. 23606.
    Over the past 30 years there has been a steady, visible
increase in the abundance of Juniperus virginiana in aband-
oned fields of Piedmont Virginia, where this species has
appeared with Pinus virginiana, P. echinata, and P. taeda
as the first woody successional species. On many disturbed
areas, such as fills and embankments, red cedar has been the
only woody pioneer, During the past 10 years the rate of
spread of this species has accelerated, and it has become
established in managed permanent Piedmont and Coastal Plain
pastures. It is also appearing in Pinus taeda plantations
in the Piedmont that are less than 10 years old.
    Red cedar is appearing with increasing frequency in aban-
doned fields of the Coastal Plain, even when seed-producing
trees of Pinus virginiana or P. taeda are nearby. Some of
these abandoned fields have over 75% red cedar and will be-
come red cedar forests, as will many old fields in the Pied-
mont. Only 3 red cedar forests with trees of saw size, all
in the Piedmont and all 10 acres or less, could be located.
    This increase in red cedar populations may be a resurge-
nce. It was a successional species in the 1700's and a comm-
ercial forest species in the 1800's in the Piedmont. There
are indications of a decline which persisted from the turn of
the century into the 1930's.

Chemistry

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

CYCLOBUTENEDIONE—OXYCARBENE REARRANGEMENT. W. B. Barham, S. C. Clough, J. D. Myers, and D. A. Clabo, Dept. of Chem., U. of Richmond, Va., 23173 and A. Johnson, L. Jaques, and J. Forehand, A. H. Robins Company, Richmond, Va., 23220.
The photolysis of 3,4-diphenyl-3-cyclobutene-1,2-dione in the presence of cyclopentadiene results in the formation of an adduct which suggests the intermediacy of a carbene. A structure proof of the adduct and a comparison of the thermal and photochemical behavior of the dione are discussed, including mechanistic implications of the various reactions.

COMPUTER-GENERATED PROBLEM SETS--A FLEXIBLE TOOL FOR CHEMISTRY INSTRUCTION. James D. Beck, Dept. of Chemistry, Virginia State University, Petersburg, VA 23803
Computers are now being used in chemical education in many different ways. One popular use is for interactive exercises such as tutorials, simulations, and drill-and-practice work. The availability of inexpensive microcomputers, some with graphics capability, has spurred the growth of this kind of computer-based instruction. At Virginia State University we have been using the computer in this interactive mode and also to generate individualized problem sets and examinations. Recently we have tied these two types of computer use together in the form of computer-generated problem sets which are checked and graded by means of an interactive program.
The problem sets are generated by a BASIC program with the answers to the questions stored for retrieval later, by either the student or instructor. The student solves the problems off-line; this permits flexibility in terms of the types of questions that can be asked and removes the constraint of computer time which may limit interactive computer use. Having worked out the answers to the questions, the student accesses an interactive program that checks the answers and provides additional information. This allows the usual advantages of interactive computing, including immediate feedback, detailed explanation of answers and methods, diagnosis of areas of difficulties, and prescription of activities which can aid the student.

CHLOROACETAMIDE PHOTOCYCLIZATION. SYNTHESIS OF 20-DESETHYLCATHARANTHINE.[1] Richard J. Sundberg and Jonathan D. Bloom. Dept. of Chemistry, Univ. of Va, Charlottesville, Va. 22901
20-Desethylcatharanthine, a potential precursor of vinblastine-type dimeric indole alkaloids, has been synthesized in 10 steps from 1-benzenesulfonylindole. The synthesis features a Diels-Alder reaction between 1-carboethoxy-1,2,-dihydropyridine and ethyl 2-(1-benzenesulfonylindol-2-yl)acrylate to construct the 7-carboethoxy-7-(2-indolyl) isoquinuclidine skeleton and photocyclization of an N-chloroacetyl derivative to introduce the C-5-C-6 (tryptamine) bridge. Reduction of the lactam is achieved via the thiolactam. With isolation of six intermediates the overall yield is 5% from 1-benzenesulfonylindole.
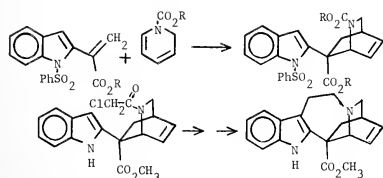
DERIVATIZATION OF ORGANIC N-CHLORAMINES, K.F. Bowdring* and F. E. Scully, Jr., Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508.
Organic N-chloramines are contaminants of chlorinated drinking water. However, until now no suitable method has been developed for their analysis in environmental systems. We have found that organic N-chloramines, generated by the reaction of their parent amine with tert-butyl hypochlorite or with commercial sodium hypochlorite, react rapidly with sodium benzenesulfinate to form benzenesulfonamide derivatives. The mechanism is probably S_N2 displacement of chloride from a nitrogen. They have been characterized by their m.p., mixed m.p. with authentic samples, IR, and NMR.
Included in the compounds studied were primary and secondary amines as well as amino acids. Of these, the primary chloramines appear to be the least stable and the sulfonamides are produced in the lowest overall yields. The secondary chloramines as well as the N-chloroamino acid in general give higher yields.
The utility of this method for the identification and quantification of organic N-chloramines will be discussed.

MAGNETIC PROPERTIES OF STRUCTURE OF A POSSIBLE CYTOCHROME c OXIDASE MODEL, BIS(HEXAFLUOROACETYLACETONATO)[N,N'-ETHYLENEBIS[2-HYDROXYPROPIOPHENONEIMINATO-N,O(2-)]COPPER(11)] IRON(11), AND OF RELATED COMPOUNDS. Greg Brewer* and Ekk Sinn Dept. of Chemistry, Univ. of Va., Charlottesville, VA 22901.

The currently popular model of the active site of cytochrome c oxidase is a strongly magnetically coupled heme iron and a copper(II) species. We have synthesized and determined the structural and magnetic properties of a series of complexes which would then be models for the active site in reduced and oxidized forms of the enzyme. The linkage was chosen so as to allow maximum magnetic coupling. In every case, the magnetic coupling in our complexes is too small by an order of magnitude to match the literature magnetic data on the enzyme. These findings raise serious questions about the model, the literature data or both. High precision magnetic measurements are being carried out in our laboratory to reevaluate the literature results on the enzyme itself.

DIRECT OXIDATION OF PHENACETIN AND RELATED AMIDES TO THEIR HYDROXAMIC ACIDS. CRYSTAL STRUCTURES OF THE DIOXOMOLYBDENUM (VI) HYDROXAMATES DERIVED FROM PHENACETIN, ACETANILIDE AND BENZANILIDE. Greg Brewer* and E. Sinn, Dept. of Chemistry, Univ. of Virginia, Charlottesville, VA 22901.

An oxidation method using diperoxo-oxohexamethylphosphoramide molybdenum(VI) has been adapted for the easy and direct conversion of phenacetin and related amides to their respective hydroxamic acids. The hydroxamic acids are the suspected toxic metabolites formed from analgesies like phenacetin and acetomenophen. Research on the metabolic pathway has previously been hampered by the difficulty in obtaining and storing the unstable hydroxamic acids. The hydroxamic acids are initially isolated as their stable dioxomolybdenum(VI) salts.

The Mo(VI) derivatives of two analgesies, phenacetin and acetanilide have been characterized by single crystal X-ray diffraction. The ligand environment about the Mo atom is a markedly distorted octahedron in each case, with the dioxo O atoms bonded cis to each other, while trans to these bonds the hydroxamate Mo-O bonds are elongated. There is no conjugation between the phenyl rings and the hydroxamic acid group.

CHARACTERIZATION OF SEVERAL FLAVANOIDS ISOLATED FROM ANAPHALIS MARGARITACEA (Pearly Everlasting). Paula Bridwell* and Samuel J. Gamble, Dept. of Chemistry., Lynchburg College, Lynchburg, Va. 24501

The flowers of Anaphalis margaritacea (pearly everlasting) were extracted in a soxlet extractor yielding flavanoid-like materials. Ethyl acetate was the solvent. Further separatory techniques with column chromatography gave four distinct compounds, each with relatively high melting points. Simple wet tests and spectrophotometric methods including NMR, IR, UV, and mass spectroscopy were used to help identify the compounds. Ashing of one of the samples revealed the presence of a metal. X-ray fluorescence was used as a confirmatory test.

Comparison of flavanoids from Gnaphalium obtusifolium (rabbit tobacco) is of interest from a taxonomic viewpoint.

THE VIBRATIONAL SPECTRA AND ASSIGNMENT OF DIMETHYLCHLORAMINE:$(CH_3)_2$NCl. R. O. Carter and T. Hizer. Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508.

The infrared spectra of $(CH_3)_2$ NCl from $4000\text{-}100cm^{-1}$ will be presented. Both gas and solid phases have been investigated. Based on an assumed structure the A″ modes of this Cs molecule should have B-type band contours while the A′ modes should display A-, C- or AC-type contours. Vibrational assignments have been made based on band contours and previous assignments for dimethylamine. Raman spectra have been recorded but are not very useful due to the formation of a polymer in laser beam.

The A″ methyl-torsion has been observed at $\sim 260cm^{-1}$. Based on an harmonic type model this results in a barrier of ~ 1400 cm^{-1} which is closer to that found for trimethylamine than to that for dimethylamine.

pH AND SOLVENT DEPENDENCE OF THE KINETIC SOLVENT ISOTOPE EFFECT IN NITROSTYRENE HYDROLYSIS. T. I. Crowell, Dept. of Chemistry, Univ. of Virginia, Charlottesville, Va. 22901.

β-Nitrostyrenes hydrolyze by adding water to form the nitroalcohol which then undergoes cleavage:

$$ArCH{=}CHNO_2 + H_2O \rightleftharpoons ArCHCH_2NO_2 \rightarrow ArCHO + CH_3NO_2$$
$$\phantom{ArCH{=}CHNO_2 + H_2O \rightleftharpoons Ar}OH$$
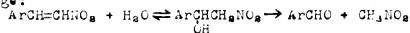
Acid-base catalysis of the hydrolysis has been studied in detail.[1]

We now report that while the rate constant in H_2O is independent of pH from pH O to 4, in D_2O the rate descends to a minimum about pH 2-3. Here the solvent isotope effect, k_{H_2O}/k_{D_2O} has the fairly large value of 6.5. This behavior is very similar to that of another system involving nucleophilic addition, the exchange of methyl borate with methanol.[a]

The rate constant for nitrostyrene hydrolysis at pH 2 is non-linear in the mole fraction of D_2O in $H_2O\text{-}D_2O$ solutions.

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STUDIES ON THE IDENTIFICATION OF AMINES IN NATURAL WATERS. P. A. Drew*, C. E. Bell, Jr. and F. E. Scully, Jr. Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508.

Despite the large amount of organic nitrogen in environmental systems few studies have identified amines in natural waters. In an effort to identify some of the labile nitrogenous by-products of water chlorination, we have begun a study aimed at identifying organic amines in pre-chlorinated water.

We have found that organic amines in concentrations of 100 ppb or less can be adsorbed from water samples by adjusting the pH of the water to 12 and passing it through a 30x65 mm column of Amberlite XAD-2 macroreticular resin. After removing excess water with dry nitrogen and equilibrating the resin with ether, the ether is filtered and concentrated. The concentrate is analyzed by gas chromatography. A local lake-water sample was analyzed in this fashion and found to contain organic compounds corresponding in retention time to suspected amines as well as neutral compounds. Methods and sample identification will be discussed.

THE INTERACTION OF HEAVY METALS WITH CHITOSAN. Catherine A. Eiden* and J. P. Wightman, Dept. of Chemistry, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061

The interaction of the natural marine polymer chitin and its deacetylated derivative chitosan with lead and chromium has been investigated. The uptake of lead and chromium was determined from changes in concentration as measured by atomic absorption spectroscopy. A significant uptake of Pb(II) on both chitosan and chitin was observed. The uptake of Pb(II) on chitin was about 21% of that on chitosan. The number density of flakes observed in the scanning electron microscope and characterized by an intense Pb signal in EDAX was greater on the surface of chitosan than on chitin after equilibration with Pb(II) solution. The bonding state of lead on chitosan as determined by ESCA is similar to the bonding of lead in PbO based on the Pb $4f_{7/2}$ binding energy. A significant uptake of Cr(III) on chitosan was observed and a significant increase in the pH solutions of Cr(III) on equilibration with chitosan occurred. A high number density of nodules characterized by an intense Cr signal in EDAX was observed in chitosan with Cr(III) solution. [This research was done in part under the 1979 NSF-Undergraduate Research Participation Program at Virginia Tech, Dr. J. W. Viers, Director].

OSMOTIC COEFFICIENTS OF AQUEOUS SOLUTIONS OF ELECTROLYTES AT VERY HIGH DILUTION. Gerald M. Evans* and S. Y. Tyree. Dept. of Chemistry, Col. of William and Mary, Williamsburg, Va. 23185

The performance of a vapor pressure osmometer has been tested with aqueous solutions of sodium chloride (0.01-0.10 molal) and calcium chloride (0.0025-0.10 molal) as a means of measuring solvent activities at very high dilutions. The results prove the vapor pressure osmometer capable of use to obtain osmotic coefficients of aqueous electrolytes at concentrations 10-fold more dilute than is possible with the classical isopiestic vapor pressure apparatus.

"TWO DIMENSIONAL ELECTROPHORETIC STUDY OF HUMAN SEMINAL PLASMA PROTEINS", E.E. Gaunt and J. H. Yuan. Department of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508.

Human seminal plasma (HSP) is a complex fluid comparable to that of blood. As such, it can be of significant value in diagnosing biochemical abnormalities associated with male infertility. A technique capable of characterizing the protein constituents of seminal plasma is high resolution two dimensional (ISODALT) electrophoresis. This technique has been used successfully in the characterization of blood plasma and serum (Anderson and Anderson, Proc. Natl. Acad. Sci., USA, Vol. 74, No. 12 (1977) and Clin. Chem. 25/7 (1979)). We have adapted this technique for use as a possible screening procedure in andrological studies.

HSP proteins are first separated by isoelectric focusing in a polyacrylamide disc gel with added ampholites. The first dimensional gel is then affixed to a SDS gradient slab gel to separate the proteins by size. Protein abnormalities arising from a change in a single amino acid residue are capable of being detected by this technique. Abnormalities have already been detected in a patient characterized as normal by cellular observation techniques.

SYNTHESIS OF HETEROAROMATIC CATIONS. Richard J. Sundberg and James E. Ellis. Depart. of Chemistry, Univ. of Va., Charlottesville, Va. 22901.

Several classes of imidazolium derivatives have been synthesized for biological screening for activity against Chagas disease, a parasitic disease caused by the organism Trypanosoma cruzi. These compounds are modeled after intercalating agents, such as ethidium bromide and related cationic compounds, which are known to have activity against T. cruzi and related organisms. Methods for synthesis of selected imidazole, benzimidazole, imidazo[1,2-a]pyridine, pyrido[1,2-a]benzimidazole and benzimidazolisoquinoline derivatives will be discussed. Additionally, methods for quaternization and introduction of side chains onto the heterocyclic rings will be covered. Typical examples are:

10-amino-12-methylbenzimidazo-[2,1-a]isoquinolinium

8-amino-1-methylpyrido[1,2-a]benzimidazolium

5.8S rRNA METHYLASE ASSAY. Pamela E. Gallup and T. O. Sitz*. Dept. of Chemistry, Old Dominion Univ., Norfolk, VA. 23508.

Mammalian 5.8S rRNA, hydrogen-bonded to 28S rRNA in the 60S Ribosomal Subunit, has two 2'-O-methylated residues, Um at position 14, and Gm at position 77. Residue 77 is methylated in all 5.8S molecules, but the percentage of 5.8S molecules in which residue 14 is methylated varies according to cell type and location in cell. Residue 14 is methylated in less than 25% of 5.8S molecules from neoplastic cells, and in greater than 75% of 5.8S molecules from normal cells. Residue 14 is not methylated in 5.8S molecules located in nuclei, but is methylated in 5.8S cytoplasmic molecules. Preliminary in vitro studies with crude cell homogenates have not detected an increase in methylation when S-adenosyl-L-methionine is added. Studies are now being conducted using high-speed supernatants of Ehrlich ascites cell homogenates as the methylase source, and purified 28S-5.8S rRNA complex from Ehrlich ascites cells as the nucleic acid source.

FLUORESCENCE STUDIES OF THE DISSOCIATION OF CUCUMBER MOSAIC VIRUS. Ellen M. George and Sandra Boatman, Dept. of Chemistry, Hollins College, VA 24020

The binding of terbium ion(Tb^{3+}) to single-stranded nucleic acid results in enhancement of the Tb^{3+} fluorescence. This paper describes preliminary experiments to determine whether this phenomenon can be used to study virus dissociation and assembly. Cucumber mosaic virus(CMV) consists of single-stranded RNA enclosed in a protein coat of 180 identical subunits. Excitation of intact CMV at 280nm gave an emission at 332nm while λex of 295nm gave the same λem but 0.6 as intense. CMV dissociation by 0.01% sodium dodecyl sulfate(SDS) exhibited λem at 337nm 0.82 as intense as intact CMV with λex of 280nm and the same λem with λex of 295 nm(same intensity as intact CMV). Significant fluorescence enhancement occurs with pure CMV-RNA(4uM)at [Tb^{3+}]s of about 0.1mM. Dissociation of virus with SDS or LiCl followed by addition of Tb^{3+} gave some enhancement of fluorescence over intact virus(1.5X), but less than expected. Reassembly of virus from the separated components was also studied. Addition to CMV-RNA of virus protein followed by Tb^{3+} resulted in less enhancement(0.50X) than shown by pure RNA (0.14 M NaCl in 0.01M Na Cacodylate pH 6.0). Addition to CMV-RNA of Tb^{3+} followed by protein resulted in somewhat greater enhancement(0.65X). NaCl caused slight quenching of the CMV-RNA-enhanced Tb^{3+}fluorescence. The use of Tb^{3+} fluorescence enhancement shows promise as a technique for studying virus dissociation but requires more study.

THE ANALYSIS OF S-ADENOSYLMETHIONINE AND S-ADENOSYLHOMOCYSTEINE IN NORMAL AND MALIGNANT CELLS. K. E. Godburn and T. O. Sitz. Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508.

Altered patterns of methylation have been shown in both ribosomal and transfer RNA isolated from cancer cells. Hypomethylation appears as a general characteristic in contrast to the elevated activity of the methyltransferases responsible for the modification. One possible explanation for this paradox is that the concentrations of the substrate, S-adenosylmethionine, and the product, S-adenosylhomocysteine, are altered resulting in substrate inhibition or competitive product inhibition. It is important to correlate the concentration of these two compounds with the 2'-O methylation level of ribosomal RNA in various tissues. These levels can be determined using phosphocellulose liquid chromatograph or high voltage electrophoresis to obtain resolution and quantitative recovery of SAM and SAH from other components. Examination of the levels in a variety of tissue culture cells suggests that the concentration of these compounds is different in specific cell types. In addition the concentration of the compounds shows a relationship with the passage number of the tissue culture cells.

A STUDY OF THE REACTIONS OF VARIOUS RUTHENIUM BIPYRIDYL COMPLEXES. S. A. Hackney*, J. S. Hanner*, and F. A. Palocsay. Dept. of Chemistry, James Madison Univ., Harrisonburg, Va. 22807

$Ru^{III}(B)(Cl)_3(H_2O)$ has been found to catalyze the oxidation of ethanol to acetaldehyde. Oxidizing agents include oxygen and ferric chloride. Experimental data suggests that the Ru^{III} compound activates the alcohol by coordination, followed by an inner sphere oxidation-reduction reaction. Upon exposure to an oxidizing agent, acetaldehyde can be distilled from the reaction mixture.

THE ELUCIDATION OF THE STRUCTURE AND MECHANISM OF FORMATION OF 2,5-DI-t-BUTYL-1,4-BENZOQUINONE EPOXIDES. E. M. Hairfield and V. A. Stepp*. John Baker Daffin Lab. of Chemistry, Mary Baldwin Col., Staunton, VA 24401

The alkaline peroxide epoxidation of 2,5-di-t-butyl-1,4-benzoquinone yields the cis and trans isomers of the diepoxide. Assignment of configuration to these isomers had been made on the basis of rather tenuous arguments based on chemical shifts, spin-spin coupling constants, and relative rates of hydrolysis. The previous workers had used mixtures of the isomers, as only 25 mg of the pure cis had been isolated by their method. We report the isolation of cis by fractional crystallization and we further show that the chiral cis isomer can be resolved, thus establishing its configuration in a totally unambiguous manner.

Studies have shown that alkaline peroxide epoxidations are first order each in olefin, peroxide, and hydroxide. Our studies confirm this general pattern for quinone spoxidation also. Furthermore, our studies show clearly that the reaction is sequential with $k_2 \ll k_1$, and the product distribution is determined by the E_a term of the Arrhenius equation rather than by ΔS^*. Implications of this are discussed, a mechanism is proposed, and directions for further study are outlined.

OPTICAL ANALOGUE OF CRYSTALS AND X-RAYS. Maureen M. Julian, Department of Chemistry, Hollins College, Va. 24020

This demonstration will optically mimic the history of the discovery of Bragg's law $h\lambda = 2d \sin\theta$ for which 24-year old William Lawrence Bragg won the Nobel prize in 1915. A mirror ball, of the type used in roller skating rinks, will represent the crystal; a beam of light will be the monochromatic X-ray beam; the light spots on the ceiling and walls will be the diffracted X-ray beams; the wall will be the film; and the room itself will be the camera. Both Laue's and X-ray powders will be demonstrated and actual X-ray photographs will be shown illustrating the remarkable similarity between the optical patterns generated on the wall and the patterns produced by real crystals diffracting X-rays.

DAME KATHLEEN LONSDALE, SCIENTIST IN ACTION. Maureen M. Julian. Dept. of Chemistry, Hollins College, Va. 24020.

Dame Kathleen Lonsdale, 1903-1971, a British chemist born in Newbridge, Ireland, was a lifelong investigator in the field of crystals and x-rays principally at the Royal Institution and later as Professor of Chemistry at University College London. In 1929 she solved the crystal structure of hexamethylbenzene, thus definitively proving that the benzene ring is flat. In recognition for her extensive work in diamonds, a mineral, lonsdaleite was named in her honor. Starting in 1962, she did research on the chemistry of bladder, kidney, and gall stones. A convert to Quakerism, she wrote and lectured extensively on the problems of peace, freedom, and justice. As a pacifist she went to jail for a month during World War II and afterwards took up the cause of penal reform. Her fright and depression about atomic weapons is reflected in her monograph, Is Peace Possible? She traveled widely, wrote, in addition to over 200 scientific papers, a text Crystals and X-rays, and edited the International X-ray Tables. In 1945 she became the first woman elected as a Fellow of the Royal Society. In 1956 she was knighted and, as a climax to her career, in 1968 she became the first woman president of the British Association for the Advancement of Science.

TRACE AMINE ANALYSIS: CORRELATION STUDIES OF BIOGENIC AMINES USING HIGH PERFORMANCE LIQUID CHROMATOGRAPHY. Thais Keegan and R. L. Williams, Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508.

Reverse phase HPLC, in which retention is a function of hydrophobic interactions between solute molecules and the stationary phase, is an increasingly popular method for single-run analysis of mixtures. The μ Bondapak phenyl column (Waters Associates, Milford, Mass.) is preferable for biogenic amines, especially catechol compounds, to octadecyl silica (C_{18}).

Pre-column derivatization of primary amines with o-phthalaldehyde and mercaptoethanol yields a highly fluorescent, stable lactim adduct capable of interaction with the column packing. The method, therefore, is applicable to both alkyl and aryl amines at picomole levels in biological material.

Retention of the adduct relative to an internal standard adduct of 3,4-dihydroxybenzylamine can be correlated to the structure of the primary amine.

Within-run mobile phase variation allows separation and analysis of the complex mixture of primary amines, especially those in the biosynthesis and metabolism of catecholamines.

STUDIES ON NIOBIUM HETEROLIGAND PEROXO COMPLEXES. K. G. Lloyd* and C. Djordjevic, Dept. of Chemistry, Col. of William and Mary, Williamsburg, Va. 23185.

Heteroligand peroxo complexes of Nb(V) are derived from tetraperoxoniobate by substituting one, two, or three peroxo groups with mono- or polydentate ligands. The syntheses are strongly pH dependent. Polycarboxylato ions have previously been found to form crystalline and stable peroxo complexes with niobium, and to continue these studies, substitution with glycine, α-alanine and proline, respectively, has been attempted. White, insoluble, X-ray amorphous substances were obtained. They are stable in air, but decompose by gradually losing peroxide on prolonged standing or heating. The $Nb/O_2{}^{2-}$ ratio of 1/1 was found in several repeated preparations. The i.r. spectra of peroxo derivatives with all the three amino acids are similar. Absorption occurring in the region 3400, 1640, 860, and 700-460 cm^{-1} is poorly resolved. Nevertheless, the range between 890-950 cm^{-1} is transparent and a niobyl stretching band, characteristic for a terminal Nb=O group, is absent. The peroxo stretching occurs at 860 cm^{-1}. Strong, complex absorption covering the wide range of 700-460 cm^{-1} indicates the presence of Nb-O-Nb bridging vibrational modes. According to analytical and spectral evidence these peroxo aminoacetato niobium complexes are polymeric, corresponding to the formula $[NbO(O_2)L]_n$, L = α-amino acid, and μ-oxo bridging, common in niobium complexes, is present.

ESTITATION OF THE PROTONATION CONSTANTS OF WEAK BASES BY SIMPLEX OPTIMIZATION. J. G. Mason and H. Bell, Dept. of Chemistry, VPI & SU, Blacksburg, Va. 24061

A modified simplex optimization program has been developed for the determination of equivalence points, calibration of the glass electrode, and estimation of the pKa from titration curves for weak bases. Both monoprotic and diprotic systems will be discussed. Data obtained yield reliable pKa values in spite of fluctuations in electrode calibration.

PRELIMINARY RING-OPENING STUDIES OF MESOIONIC PURINONES, G.O. Mbagwu, R.G. Bass and R.A. Glennon, Depts. of Chem. and Pharm. Chem., Virginia Commonwealth Univ., Richmond, Va. 23284.

Mesoionic thiazolo[3,2-a]pyrimidin-5,7-diones 1 are known to undergo ring-opening with amines.
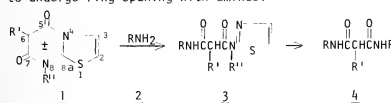
The ability of these compounds to function as acylating agents, may account for their in vitro biological activity. The mesoionic compounds 1, (R'=H, CH_3, CH_3CH_2; R''=CH_3CH_2) were reacted with a series of amines 2 (R=Ph, $PhCH_2$, $CH_3CH_2CH_2$, $(CH_3)_2CH$, $(CH_3)_3C$) in refluxing tetrahydrofuran give a high yield of the ring-opened product 3. When R'=CH_3, CH_3CH_2; R''=CH_3CH_2, the mesoionic compound does not react with benzylamine in refluxing THF or dioxane. Reacting 1 (R'=R''=CH_3CH_2) in refluxing phenethyl amine gives rise to 4. Preliminary kinetic studies of the reaction of phenethylamine and 1 (R'=H, R''=CH_3CH_2) in THF at 66°C indicate a second-order rate constant of 8.3 lit mole^{-1} sec^{-1}.

This work was supported in part by the U.S. Public Health Service Grant No. HL22566.

PYRIDINE ANALOGS OF PHENCYLIDINE. J. McKenney and R. L. Williams, Dep't. of Chemical Sciences, Old Dominion University, Norfolk, VA. 23508.

Phencyclidine 1 (PCP) has established itself over the past ten years as a drug of abuse and considerable research has been conducted into its mechanism of action and structure-activity studies. An examination of the recent literature related to the various analogs of PCP has shown that the only heterocyclic analog reported to date in the thiophene derivative TCP 2. This laboratory has undertaken a synthetic program to synthesize a variety of heterocyclic analogs including the pyridine and benzimidazole structures 3 and 4. This paper will discuss the various synthetic routes he have attempted and anticipate in the search for these new heterocyclic derivatives.

PREPARATION OF C-SUBSTITUTED DERIVATIVES OF 1,2,3-(η^5-C_2H_2)CoC$_2B_3H_7$ BY THE REACTION OF 2-(η^5-C_2H_2)CoB$_4H_8$ WITH SUBSTITUTED ALKYNES. V.R. Miller and C.C. Corcoran*. Dept. of Chemistry, Roanoke Col., Salem, Va. 24153

As in gas phase reactions, 2-(η^5-C_2H_2)CoB$_4H_8$ will react with substituted acetylenes in solution to yield C-substituted derivatives of 1,2,3-(η^5-C_5H_5)CoC$_2B_3H_7$. Thus, the reaction at 100°C of phenylacetylene with $C_5H_5CoB_4H_8$ for 24 hrs. in decane under nitrogen gave 1,2,3-(η^5-C_5H_5)Co (C_6H_5)C$_2B_3H_6$. In a similar manner 1,7-octadiyne reacted to give 1,2,3-(η^5-C_5H_5)Co (HC≡C(CH$_2$)$_4$)C$_2B_3H_6$, and diphenylacetylene reacted to give 1,2,3-(η^5-C_5H_5)Co(C_6H_5)$_2C_2B_3H_6$. The later compound was not stable at this temperature and reacted further to give C,C'-disubstituted 1,7-(η^5-C_5H_5)$_2$Co$_2(C_6H_5)_2C_2B_3H_3$ and other, unidentified products. There was no evidence for the addition product found by Grimes et. al. in the corresponding gas phase reaction. (Supported by a Research Corporation Cottrell College Science Grant. Appreciation to Univer. of Virginia, Dept. of Chemistry for assistance in obtaining spectra.)

C-13 NMR OF METAL-FREE AND METAL-SUBSTITUTED CARBONIC ANHYDRASE. P.J. Morley* and R.G. Khalifah.* Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901

Carbon-13 NMR in conjunction with selective isotopic enrichment has been used to study the effects of removal of the intrinsic zinc from the active-site of human erythrocyte carbonic anhydrase. His-200 was carboxymethylated using 90% 1-^{13}C bromoacetate which introduced a "probe" into the active site. The resonance of the enriched carboxylate is easily detected and was previously shown to be sensitive to changes of pH and inhibitor binding in the zinc enzyme. Data on the zinc carboxymethyl enzyme gave evidence for a zinc-carboxylate coordination. Most recently derivatives of the enzyme were prepared by removal of the zinc and the enzyme was reconstituted with metals such as Co^{2+}, Cd^{2+} (including $^{111}Cd^{2+}$) and Hg^{2+} (including $^{199}Hg^{2+}$). The possible interaction of these metals with the introduced carboxylate has been investigated. Using chemical shift studies, 2-bond coupling techniques and spin-lattice relaxation times, this interaction has been ruled out in the inactive Cd^{2+} and Hg^{2+} derivatives as well as inhibitor complexes of the enzyme.

Chemical shift behavior of the enriched carboxylate resonance has permitted determination of the pK$_a$ of the imidazole ring of carboxymethylated-His-200 in various metalloderivatives in the presence and absence (usually) of inhibitors indicating dramatic changes of its properties.

THE METHOD OF PSEUDOPOTENTIALS. Eileen O'Brien*, J. C.
Schug and G. Sanzone, Dept. of Chemistry, VPI & SU,
Blacksburg, VA 24061.

Pseudopotential theory[1] suggests a valid and simpli-
fied valence-electron approach to electronic structure
calculations of atoms and molecules. The effective replace-
ment of the core electrons of an atom by a pseudopotential
is discussed, and the properties of a pseudopotential are
deduced from its explicit functional form. Various
workers[2] have generated ab-initio pseudopotentials for
atoms located as far down as the 5th row of the periodic
table. Hartree-Fock molecular calculations over large but
"coreless" atomic systems are now tractable, since the
total number of electrons to consider is just the number of
valence electrons contributed from each atom. Recent ab-
initio calculations incorporating the prescribed pseudo-
potentials[3] have been performed on Hg and Hg_2. The
results of these calculations are presented.

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POLYCARBOXYLIC ACID POLYMERS AS ANTITUMOR AGENTS.
Raphael M. Ottenbrite, Department of Chemistry, Virginia
Commonwealth University, Richmond, VA   23284.

Anionic polymers have been shown to be excellent im-
munopotentiators and do inhibit tumor growth. Like most
other agents in this class, they possess certain toxici-
ties that limit their usefulness. However, our studies
indicate that the toxicologic actions of pyran, for ex-
ample, are a function of high molecular weight species
which are not necessary for therapeutic activity. By pre-
paring new anions and using separation techniques it ap-
pears that polyanionic anti-neoplastic immunopotentiators
can be prepared which are devoid of adverse clinical limit-
ing effects. Additionally, identification of the molecu-
lar weight species essential for this activity may stimu-
late research into the host receptor responsible for the
antitumor activity.

The copolymers were characterized through NMR, elemental
analysis, titrations, and viscosity. Biological evalua-
tions carried out include; antiviral activity against en-
cephalomyocarditis (EMC) virus, antineoplastic activity
against Lewis lung carcinoma and Friend leukemia, activa-
tions of macrophage, effect on microsomal enzymes as in-
dicated by the prolongation of hexobarbital sleeping time
and an evaluation of hepatosplenomegaly.

ELECTRON IMPACT STUDIES OF ARGON DIMERS. Edward E. Rickman*
and G. Sanzone, Dept of Chemistry, VPI & SU, Blacksburg,
VA 24061.

Van der Waals diatomic molecules of rare gases have
been formed in pulsed free jet expansions with a nozzle-
beam apparatus. Direct ionization and excitation of these
species can be studied in crossed electron-beam/molecular
beam experiments which employ mass spectrometric and
fluorescence detection. In this paper, the design and
fabrication of an electron beam is described for the
determination of ionization potentials of rare-gas
diatomics by the RPD method. The RPD method for molecular
beam studies is discussed along with the possible ion
species detected. Attention is then focussed on the species
$Ar_2{}^+$.

ANALYSIS OF DIPOLE MOMENTS FOR BINARY MOLECULES USING A
POINT-CHARGE COULOMBIC MODEL. L. J. Sacks, Christopher
Newport College, Newport News, VA 23606

The dipole moments of binary hydrides are assessed using
a point-charge model in which four pairs of electrons are
arranged around the core of the central atom, one or more of
these containing a proton, and the assemblage treated
according to the molecular symmetry (C_{nv}). The E-H distance
is used to establish the contribution of the hydride ion to
the molecular dipole and then the angles and distances to
the center of charge for the line pairs are considered in
light of both qualitative expectation, using minimum repul-
sion considerations, and quantitative calculations of the
two-parameter systems. In the cases of ammonia and phos-
phine, unique solutions result, and these are used as ref-
erence situations for other molecules. The concept of "bond
dipole" is reconsidered in light of the charge distributions
needed to accommodate the "partial ionic character" of
molecules such as HCl and the so-called "covalent" bond
which would have zero dipole moment. The description of the
wave function embodying these postulated models is compared
with that for the point charge model.

STUDIES OF THE STRUCTURES PRODUCED BY RADIATION DAMAGE TO
DNA. Karl A. Schellenberg and James Shaeffer, Department of
Biochemistry and Department of Radiation Oncology and
Biophysics, Eastern Virginia Medical School, Norfolk, VA.
23501.

The irradiation of aqueous solutions of native calf
thymus DNA with x-rays produced borohydride reactive sites.
The sites were labeled with tritium by reacting the DNA with
NaB^3H_4 in NH_4Cl buffer, and the labeled DNA was precipitated
with trichloroacetic acid, collected on a glass fiber
filter, and assayed for tritium and ultraviolet absorption.
The DNA incorporated tritium to the extent of about 2.0 x
10^{-10} atom ^3H/dalton/rad. The tritium-containing moiety,
presumably an altered deoxyribose residue at the strand
end, was relatively stable to dilute alkali. Hydrolysis
of the labeled DNA in 6M HCl for 6 h at 120° gave 4 tritium-
labeled products as determined by thin layer chromatography.
The four products appeared identical with those obtained
from DNA damaged by chemically generated hydroxyl radicals,
and two of the products appeared identical with products
obtained by hydroxyl radical reaction with deoxyadenosine
or thymidine. Possible structures of these products will
be discussed.

STUDIES ON THE DECOMPOSITION OF N-CHLORO-
PIPERIDINE IN AN AQUEOUS MEDIUM. J. Schlager*
and F. E. Scully, Jr., Dep't. of Chemical Sciences, Old
Dominion Univ., Norfolk, VA. 23508.

Organic N-chloramines are understudied components of
chlorinated water. Little is known of their lifetime or
stability in an aqueous medium. Because N-chloro-
piperidine (NCP) is a strongly suspected contaminant of
chlorinated water, the stability of NCP in aqueous
buffered solutions was examined at 25° in 0.1 M potassium
phosphate and 0.4 M NaCl at pH's of 1.0 to 9.0. The first
order decay rate is constant over the pH range 3.0 to 9.0
and the calculated half-life is about 7 days. At pH's lower
than 3.0 the decay rate increases dramatically as the
solution becomes more acidic. A mechanism and possible
products will be discussed.

A study of the model metabolism of NCP has also been
undertaken. In the presence of the Udenfriend model
metabolism system NCP is converted largely to piperidine
along with other minor products. The health implications
of these data will be discussed.

THE REDOX CHEMISTRY OF URANIUM IN MOLTEN SILICATES. Henry D. Schreiber and Stephen M. Andrews, Dept. of Chemistry, VMI, Lexington, VA 24450.

An understanding of the oxidation-reduction chemistry of uranium in molten silicates has direct application to problems in nuclear waste disposal, geochemistry, and glass manufacture. The uranium redox equilibrium in Ca-Mg-Al-silicate melts has been determined as a function of the base composition, melt temperature, imposed oxygen fugacity, and total uranium content. Evidence of a U(VI)-U(V)-U(IV) equilibrium in the molten silicates has been established. The equilibrium is relatively insensitive to melt temperature and total uranium content, but is quite dependent on the base composition and imposed oxygen fugacity. Through comparisons with previous studies of other redox couples in analogous melts, uranium has been placed in a reduction potential series for a silicate melt as a solvent; in order of ease of reduction, $Ce(IV) \rightarrow Ce(III)$ > $U(VI) \rightarrow U(V)$ > $Fe(III) \rightarrow Fe(II)$ > $U(V) \rightarrow U(IV)$ > $Cr(III) \rightarrow Cr(II)$ > $Eu(III) \rightarrow Eu(II)$ >> $Ti(IV) \rightarrow Ti(III)$.

THE FIRST SPIN STATE EQUILIBRIUM IN ANY d^4 COMPLEX; AN ALTERNATIVE CYTOCHROME c OXIDASE MODEL. MAGNETIC PROPERTIES AND CRYSTAL STRUCTURE OF TRIS[1-(2-AZOYL)-2-AZABUTEN-4-YL]AMINEMANGANESE(III). Greig Sim[a] and Ekk Sinn, Dept. of Chemistry, Univ. of Va., Charlottesville, VA 22901.

An equilibrium is theoretically possible between the high spin and low spin states of d^4 complexes, but this has never been observed. This is the only d^n configuration for which a theoretically possible equilibrium could not so far be experimentally verified. The title complex has this spin equilibrium and its magnetic, structural and spectral properties will be reported.

The currently popular model for the active site in the oxidized form of cytochrome c oxidase involves a strong magnetic coupling between Fe(III) and Cu(II) atoms. This model could well be wrong, and the literature magnetic data for the enzyme could be explained as well by an Fe(IV) heme center (quite possible for porphyrin derivatives) and an inactive Cu(I) center. The Fe(IV) would have to exhibit a spin equilibrium to match the literature data. Fe(IV) has configuration d^4, for which a spin equilibrium is theoretically possible and has now been experimentally verified.

TRACE METALS IN RAINWATER. Pamela T. Simpson[*] and Neal G. Sumerlin. Chemistry Dept., Lynchburg Col. Lynchburg, Va. 24501

The concentrations of several trace metals in rainwater samples collected over a 4-month period have been measured by atomic absorption spectrometry. The trace metals were first concentrated by diethyldithiocarbamate chelating agent, then extracted with methyl isobutyl ketone. Using this method, parts-per-billion levels of trace metals have been detected.

The highest levels seem to be in small, presumably dirty, rainfalls. Further testing is contemplated to determine the amount coming from solid material suspended in the rain, and to follow concentration changes within a single rain.

ELECTRON PAIRING EFFECTS AND THEIR RELATION TO STRUCTURE IN SOME NICKEL(II), COBALT(III), AND COPPER(II) COMPLEXES. T. Thanyasiri[a] and Ekk Sinn, Department of Chemistry, Univ. of Va., Charlottesville, VA 22901.

Pairing and unpairing of electrons in mononuclear d^6 and d^8 and in binuclear Cu(II) complexes have been investigated in order to relate structures to their magnetic properties. For d^6 system, a second known Co(III) complex, exhibits spin state crossover proven by temperature dependent magnetic measurements, was prepared. In the Ni(II), d^8 complexes $[Ni(L)_4X$, where L = some substituted thioureas and X = Cl or Br], we found that their temperature dependent magnetic moments are due to effects of two different phenomena, not just an effect of spin crossover alone. Structural features influencing ferro- and antiferromagnetic interactions in binuclear Cu(II) complexes were studied by designing compounds in which the two interactions are in balance. $[Cu \, dien \, Cl]_2(NO_3)_2$ is an example of such compounds.

MODELLING COMPLEX CHEMICAL SYSTEMS WITH THE MICHIGAN EXPERIMENTAL SIMULATION SYSTEM: CHEMICAL SWITCHES AND OSCILLATORS. Don Thomason and Carl Trindle, Dep't of Chemistry, University of Virginia, Charlottesville, VA, 22903.

Chemical oscillations occur under non-equilibrium conditions. Most mechanistic schemes for chemical oscillators have an autocatalytic step, creating instability. The nonlinear autocatalytic step leads to a possibility of multiple steady states. Both temporal and spatial structure may develop in the course of the reaction. We have examined the glycolysis oscillator experimentally and with the aid of the Michigan Experimental Simulation system, and established that the oscillations in this system agreed in phase only in small regions characterized by a critical length of ca. 0.025 cm, producing locally ordered structures. Similar local order would have been required to generate structure - and eventually life - from the "primordial soup".

THE SYNTHESIS AND REACTIVITY OF MOLYDENUM COORDINATION COMPLEXES. Joseph Topich, Department of Chemistry, Virginia Commonwealth Univ., Richmond, Virginia 23284

Molybdenum is an unusual transition element in that it can exist in oxidation states +6 to -2. This versatility makes molybdenum an attractive candidate for several redox enzymes, most notable is nitrogenase. We report here on monomeric molybdenum coordination complexes that serve as potential molybdoenzyme models. Cis-dioxomolybdenum(VI) complexes incorporating tridentate Schiff base ligands have been synthesized and characterized. Cathodic reduction potentials are controlled by subtle ligand modifications. Molybdenum complexes have also been covalently attached to insoluble polystyrene to block molybdenum(V) dimer formation. EPR data will be presented and the reaction chemistry of these complexes with nitrate and triphenylphosphine will be discussed.

STUDIES ON THIOUREA COMPLEXES OF LINEAR POLYARYLS. Ann Tyree* and James B. Patrick, John Baker Daffin Lab. of Chemistry, Mary Baldwin Col., Staunton, Virginia 24401

Canal-type inclusion complexes of thiourea and methyl-branched aliphatic hydrocarbons are well known, but there are a few cases such as p-di-tert.-butylbenzene which suggest that complexes of some aromatics are possible. Models also support this speculation. Analogy with the aliphatic cases indicates that the ratio thiourea:hydro-carbon should increase as the aromatic substrate molecules increase in length.

We have studied the reaction, under conditions for complex formation, of thiourea with biphenyl, p-terphenyl, p,p'-di-tert.-butybiphenyl, and p,p'-di-tert.-butyl-p-terphenyl. Crystalline substances containing both thiourea and hydrocarbon were obtained in all cases, but the ratio of thiourea to hydrocarbon was less than 1 with the three cases where no tert.-butyl groups were present; these 3, therefore, can not be inclusion compounds. The ratio of thiourea:hydrocarbon was greater than 1 for the three tert.-butylated hydrocarbons, but it was small and decreased with increasing length of the guest molecule. It seems doubtful, therefore, if any of these substances are true canal inclusion compounds. However, if they are not, the models require reinterpretation and the case of p-di-tert.-butylbenzene, which has hitherto been accepted in the literature as a true inclusion compound, is called into question.

STUDIES ON VANADIUM HETEROLIGAND PEROXO COMPLEXES. P. L. Wilkins* and C. Djordjevic, Dept. of Chemistry, Col. of William and Mary, Williamsburg, Va. 23185.

Heteroligand peroxo complexes of V(V) can be derived from a variety of existing peroxo and oxoperoxo vanadium species. To be distinguished from niobium, vanadium complexes sepa-rated from acid or neutral solutions invariably possess terminal or bridging oxo groups. We have investigated preparation of peroxo polycarboxylato and aminocarboxylato vanadates, analogous to compounds characterized previously for niobium. Crystalline ammonium and potassium salts of peroxo vanadates containing nitrilotriacetato and iminodi-acetato ligands were obtained. They contain two peroxo groups and a polycarboxylato ligand per metal ion, and the i.r. spectra show characteristic strong bands in the 960–840 cm^{-1} region. The compounds are stable at room temperature and do not lose peroxide on prolonged standing. Attempts to prepare peroxo-α-aminoacetato vanadates, as obtained for niobium, were not successful. Chemistry of these heteroligand peroxo vanadates seems to have little in common with the chemistry of peroxo niobates. Redox behavior of coordinated peroxo group in various complexes was investigated in aqueous solutions. It was observed that in certain ligand spheres superoxide intermediate is formed. The potential of peroxide oxidation via $O_2{}^{2-} \rightarrow O_2{}^- \rightarrow O_2$ will be discussed.

POTENTIAL ANTITUMOR AGENTS: 2,2'-BIPYRIDYL THIOSEMICARBAZONES AND THEIR METAL COM-PLEXES. R. L. Williams, L. Wolfinbarger and A. Principe'. Dep'ts. of Chemical Sciences and Biological Sciences, Old Dominion Univ.,Norfolk,VA. 23508.

α-Heterocyclic thiosemicarbazones such as 1 have been shown to be effective antitumor agents against a variety of tumor lines. We wish to describe our con-tinued research in the synthesis and evaluation of a series of 2,2'-bipyridyl thiosemicarbazones 2 and 1,8'-diazafluenonthiosemicarbazones 3. These compounds together with the iron and copper complexes of 2 have been shown to be active against Ehrlich Ascites tumor cells in mice. These findings have now been supported by recent studies which indicate that both the ligand 2 and its metal complexes are effective inhibitors of the target enzyming, ribonucleotide reductase. This paper will describe the most recent results from the in vitro studies with these compounds and proposals for future work.

ION CHROMATOGRAPHY: INTERFERENCE OF CHLORIDE IN SULFATE DETERMINATION. William E. Weiser* and S. Y. Tyree. Dept. of Chemistry, Col. of William and Mary, Williamsburg, Va. 23185

A study was conducted of the effect of large variations in chloride ion concentration upon the determination of sulfate ion in the 0–100 ppm range. The solutions studied contained only sodium chloride and sodium sulfate, using a Dionex Model 14 Ion Chromatograph. Up to 4000 ppm chloride the sulfate peak is independent of the amount of chloride present. Above 4000 ppm chloride the sulfate peak is affected by variations in chloride concentration.

CONDENSATION PRODUCTS OF HISTAMINE AND ORTHOPHTHALDEHYDE. R. L. Williams and Bev Renfrow, Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508.

The condensation of histamine with orthophthaldhyde (OPT) was first described by Shore et al. in 1959. This reaction was initially found to give rise to a fluorescent product, and this reaction has been used as a means of assaying for histamine in biological samples for some years. The structure proposed for this product is shown below, 1.

We have recently re-examined this reaction and the nature of the fluorescent product and wish to present synthetic and spectral data which suggest that the product is actually the isoindolin (2). This structure is currently under further investigation as in the reaction OPT with other biogenic amines.

ISOLATION OF AN ACTIVE, COPPER-CONTAINING FRA-GMENT OF HUMAN SERUM FERROXIDASE-II. James H. Woodruff and Richard W. Topham, Dept. of Chemistry, University of Richmond, Va. 23173.

Ferroxidase-II is a large and structurally complex enzy-me of human serum that has been proposed to facilitate the mobilization of iron from storage tissue by promoting the oxidation and incorporation of iron into the serum transport protein, transferrin. It possesses protein-bound lipid and copper components which are essential for the maintenance of its catalytic activity. An enzymically active, low molec-ular weight fragment of ferroxidase-II has been generated by proteolytic cleavage with chymotrypsin. The active frag-ment was purified by gel-filtration and ion-exchange chro-matography. The purified fragment possesses high concen-trations of bound copper and lipid components, both of which are essential for the maintenance of its activity. Further-more, the fragment is kinetically similar to native ferroxi-dase-II. This fragment appears to constitute the active site(s) of ferroxidase-II. Detailed structural studies of this fragment should provide considerable insight into the nature of the active site of this physiologically important enzyme. (Supported by USPHS, NIH Grant 2-R01-AM 20148-03 and a faculty research grant from the Univ. of Richmond).

STUDIES OF NAD GLYCOHYDROLASE ISOZYMES FROM
BULL SEMEN. S. D. Yeatts and J. H. Yuan. Dep't. of
Chemical Sciences, Old Dominion Univ., Norfolk, VA.
23508.

NAD glycohydrolase (NADase), capable of catalyzing
the hydrolysis of the nicotinamide N-ribosidic linkage of
NAD, was purified previously by conventional procedure
(J. Biol. Chem., 246:2111,1971). In search for a
simple, rapid procedure for the preparation of this
enzyme, it was found that Matrex Red A (Amicon) gel
served very well as an affinity gel for NADase. The
enzyme was found to the Matrex Red A affinity column in
10 M sodium phosphate buffer, pH 6.0, and two fractions
of NADase activity were obtained when the column was
eluted with a linear gradient of NaCl from 0-2.5 M.
NADase I and II were eluted at a NaCl gradient at 0.25 M
and 1.20 M respectively.

Molecular weight of NADase I and II were estimated to
be about 60,000, and this indicates that both of these
isozymes exist in a dimeric form. Most surprisingly, both
NADase I and II were found to catalyze a pyridine base
exchange reaction which has not been reported before.
Details of the kinetic and pyridine base exchange studies
will be described.

Education

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

USING COMPUTERS IN SCIENCE INSTRUCTION: WAYS AND MEANS.
James D. Beck, Dept. of Chemistry, Virginia State Univ.,
Petersburg, VA 23803
     Although the number of high schools and colleges which
have access to computers for instructional use has in-
creased dramatically over the past few years, their impact
on science instruction has been very slight. Is it time
for the computer to play an important role in the science
classroom? Or are we still waiting for the computer revolu-
tion to reach the field of education?
     Most of the arguments which science teachers have used
to justify their ignoring the computer as an instructional
tool are no longer valid. Inexpensive microcomputers are
becoming popular everywhere (even in schools!), and the
amount of computer-based learning materials is increasing
rapidly. And one does not need to become a computer pro-
grammer in order to utilize the computer in the classroom.
Books and college courses on computer-based instruction
can illustrate the ways in which the computer can be used
and the advantages to be gained by using it.
     Your students can benefit from computer-based experi-
ences--tutorials, problem-solving work, drill-and-practice
exercises, simulations, graphics demonstrations, computer-
generated problem sets, etc. Beg, borrow, or buy a micro-
computer or live terminal. Get some programs in your field.
Try them. Let some of your students try them. See if you
don't agree that the computer can excite and enlighten
your students and rejuvenate your teaching.

COMMUNITY BASED PROGRAM FOR GIFTED SCIENCE STUDENTS.
Mariana R. Becker, and Jeane J. Dughi, Science Division,
Department of Instruction, Norfolk Public Schools, Norfolk,
VA. 23510
     The Norfolk Public Schools secondary gifted program is
designed to provide the student with research skills, an
opportunity to utilize these skills through scientific
investigations and participation in scientifically
oriented community resources such as Eastern Virginia
Medical School, NASA at Langley Air Force Base, and local
Universities.

BREADTH, DEPTH, AND MOUNTAIN PEAKS: COMPLETING THE
LEARNING CYCLE. Michael L. Bentley, Supervisor of
Science, Va. Dept. of Education, Richmond, Va. 23216
     Fiscal restraint and 'back-to-the-basics' have
endangered special activities for children, such as
field trips. Recent educational and neuroscience re-
search supports the value of such experiences for
cognitive growth. The potential of field experiences
for learning may be more pronounced at certain ages.
Children at different developmental levels respond in
different ways to site characteristics. Field acti-
vities can be structured to maximize meaningful
interaction between learner and environment. Efforts
to evaluate "peak" experiences must take account of
long term effects which act in areas of the learning
cycle often ignored in educational practice. The Va.
Dept. of Education's Project OUTSIDE is developing
field site guides for the seven regions of Virginia.
These guides will provide teachers with background
information about the site and will be designed for
learner inquiry.

ISIS and the NDN. R.N. Giese. Sch. of Educ., Col. of William
and Mary.
     In 1977-78 the effectiveness, for nonscience prone second-
ary students, of the 34 commerically available minicourses in
the Individualized Science Instructional System was tested.
The testing program involved 33 teachers and 1468 (nonscience
major) secondary students in 7 states. Each teacher selected
6 minicourses (about 400) were put into a pool and randomly
distributed in test packets containing about 35 items. Each
student was given the same test as a pre & post test.
     Each nonscience prone student using the ISIS program com-
pleted 4 or 5 minicourses each semester. All other students
in the participating schools were science prone and taking
traditional science courses. Thus the control group for each
minicourse was made up of the students using ISIS but who had
not done that particular minicourse.
     The reliability of the tests were found to be between .72
& .90 (KR_{20}). The pre & post test scores for each minicourse
were found to be significantly (at the .05 level) different.
For each minicourse the pre & post test score was 45% or be-
low and the post test score was 60% or above.
     Based on such data ISIS was approved by the Joint
Dissemination Review Panel for inclusion in the National
Diffusion Network.
     In Va. this means that local school systems can write a
proposal for adopter/adapter grants & receive federal funds
to cover the cost of securing the project's materials,
teacher training, and evaluation.

THE DORM EFFECT AND ATTAINMENT OF THE BACCALAUREATE DEGREE. Bernard H. Levin, Blue Ridge Cmnty. Col., Weyers Cave, VA 24486, and Darrel A. Clowes. Virginia Tech, Blacksburg, VA 24061.

This study examines data from the National Longitudinal Study of the High School Class of 1972 to test the relationship between residential status of full-time students and receipt of a four-year degree within four years of high school graduation. Such degrees were obtained by 55% of those initially attending a four-year college and living with their parents, and by 66% of those initially attending a four-year college and living in a dormitory or college apartment (N = 597, CHI Squared = 6.13, p $<$.02). Available data on student characteristics did not provide alternative explanation; the NLS data unambiguously establish a "dorm effect."

THE PROBLEM THAT WON'T GO AWAY. W. A. Moyer. National Association of Biology Teachers, Reston, VA 22090.

The creationist doctrinal position includes belief in absolute integrity of Holy Scripture, the Triune God, direct creation of all things, man created in God's image, and the biblical framework of history. Problems arise when students with such a belief structure encounter science courses. Wendell Bird, a creationist lawyer, argues that teaching evolution solely denies free exercise of religion for such students, proposing the remedy of neutralization (instruction in both concepts) or elimination of evolution instruction. A model bill containing such provisions has been introduced into at least 4 state legislatures. "Scientific" creationism is therein defined as belief in special creation, fixity of originally created kinds of organisms, distinct ancestry of man and apes, a world-wide flood and recent origin of earth and life. Evolution is also defined along with evidence to be used in teaching both concepts. The action clause provides that if evolution is taught, creationism must also be taught in a balanced fashion. If passed into law, science teachers would be required to teach theology and scientific truth as defined by law, not science. Appropriate responses include developing professional competence in evolutionary theory, education of the public and political activity. NABT has organized a committee on Evolution Education and will publish a newsletter drawn from material in its files.

BLOCK SCHEDULING: CRISES IN ENROLLMENT AND ENERGY DEMAND A NEW APPROACH FROM VIRGINIA'S COLLEGES AND UNIVERSITIES James P.B. O'Brien, Division of Social Sciences, Tidewater Community College, Virginia Beach, Va., 23456

Throughout Virginia and the nation, evening college classes are regularly taught in 3-hour blocks. Students are attracted to evening classes because they can reach educational and career goals and at the same time meet their needs for employment, child care, and the most efficient allocation of temporal and financial resources. As the complexion of the work force changes (more women, more older workers, more needs for skills acquisition or refinement), as the traditional population of educational consumers wanes, as transportation becomes more expensive, and as jobs and services scheduling becomes more innovative (flextime, 4-day weeks, 5 and 4-bimonthly variations); institutions offering educational services, especially those with substantial commuter populations, will remain attractive only to the degree that they are responsive to the changes and pressures facing potential students. A tried and successful method, namely; 3-hour block scheduling, should be made available during daytime sessions to enable students to use educational resources most efficiently. The benefits to a state that has substantial tourist and leisure industries dependent on personal transportation are also noteworthy.

MATHEMATICS FOR ELEMENTARY SCHOOL TEACHERS: AN ACTIVITY APPROACH. Delbert Snyder*. Dept. of Mathematics, Eastern Mennonite College, Harrisonburg, VA 22801.

Based on the assumption that mathematics learning is enhanced when children are actively involved in manipulative experiences, the Fresno Pacific Mathematics Project, headed by Dr. Arthur Wiebe, has developed a series of inservice courses for elementary teachers which provide materials and expertise necessary to implement an activity-oriented approach to elementary mathematics. A second objective of the Project is to improve teacher attitudes toward mathematics, since it is believed that a major block to improved mathematics instruction is unfavorable teacher attitudes.

The Project courses and materials have been used by more than 5000 teachers in California, Oregon and Virginia over the past eight years. Conclusive results are not available, but informal field studies indicate that improvements in both student learning and teacher attitudes have occurred through this program. In one study, 196 teachers used the materials in their classes over a period of 60 days for 5-7 minutes per day to drill and reinforce basic computation skills. Test results show that their students gained an average of 1.3 grade levels in those skills during that time period. In another survey of 4000 teachers, 75% stated that their involvement in the Project had resulted in a marked improvement in their attitudes toward mathematics; for 10%, mathematics had risen from a dreaded subject to a favorite subject due to increased confidence and student enthusiasm.

TEACHING STATISTICS TO SECONDARY SCHOOL STUDENTS A NOVEL APPROACH. H. W. Straley . Dept. of Math, Woodberry Forest Sch, Woodberry Forest, VA. 22989

The most important reason many high school students continue to study mathematics is their perception of its usefulness in their futures. Inferential statistics is an area of mathematics that can be taught to students who have only an elementary algebra background. It is also an area of mathematics for which real world applications are easily understood by pre-college students. Inferential statistics may be the only area of mathematics that meets both of the above conditions.

This paper describes an innovative six week unit on inferential statistics that has been successfully taught to Algebra II students. The unit has also been expanded into a term course without increasing teacher loads. The term course expands upon the statistics content by providing an opportunity for students to write and orally present a statistically oriented research paper.

In addition to describing course content and organization the author presents sample test items and provides data on student achievement. Some student papers are available and some preliminary research data on the attitudinal effects of the statistics unit are presented.

BIOETHICS: ADOPTED OR STILL ORPHANED? P. J. Thompson, K. A. Banschick, C. J. Boyne, C. A. Chiaramonte, L. M. Crowley, J. D. Dickens, D. D. Leonard, and J. R. Smith. Dept. of Biology, Univ. of Va., Charlottesville, Va. 22901

Bioethical issues surfaced when scientists--through increased technology--learned to manipulate natural life processes. A systematic examination of four major science journals demonstrates fluctuating coverage of bioethical issues in the last decade. A survey of six widely-used general biology textbooks illustrates a gradual increase in coverage. Preliminary examination of a timeline of bioethical issues for the past ten years suggests possible historical correlates for these observations.

Engineering

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

CO_2 TRANSPORT IN BRAIN CHEMORECEPTORS. J. Milton Adams* and M. L. Severns*, Div. Biomedical Engineering, Univ. of Va., Charlottesville, Va. 22908

One of the primary inputs which controls breathing is the CO_2 partial pressure of arterial blood ($PaCO_2$). The processes involved include convective and diffusive transport in a spatially random network of capillaries. Using the distributed parameter Krogh model (two concentric cylinders) we have developed a lumped parameter compartmental model which predicts the time course of spatially averaged PCO_2 of chemoreceptor tissue ($\bar{P}tCO_2$). If the solution for $\bar{P}tCO_2(r,t)$ is formed for a step change in $PaCO_2$ in the diffusion limited case, a series of Bessel functions results. We next solve for the trans-compartment flux (from the Bessel series) which is: $n_{CO_2} = K\partial PtCO_2/\partial r|_{r=a}$. Since the first term from the resulting series accounts for 98% of the total flux, a first order process will be appropriate. The lumped parameter mass transfer coefficient is chosen to give the same flux as for the Krogh model. We then integrate the steady state solution to find $\bar{P}tCO_2$, which for brain is: $\bar{P}tCO_2 = (Pa + Pv)/2 + 1$ (mmHg) where Pa and Pv are arterial and venous PCO_2 respectively. The main difference between this lumped model and previous ones is that the $\bar{P}tCO_2$ is not equal to $PvCO_2$. In addition, we have shown how the compartmental model relates to the Krogh predictions. (Supported by NIH grant GM 07593).

A HIGH-SPEED CENTRIFUGE FOR REMOVING FLY-ASH FROM FLUE GAS. R. J. Babarsky* and S. S. Fisher, School of Engr. and Appl. Sci., U. Va., Charlottesville, VA 22901.

The design of a high-speed centrifuge for separating fly-ash particles from a continuous flue-gas stream is described. The device consists of an impeller (similar to that for radial compressor) which accelerates the gas to high angular velocity, a multiple-annulus settling chamber in which the fly-ash particles are removed, and a second impeller used to decelerate the gas after separation is complete. Because this centrifuge rotates at very high speeds (400 m/s rim speed), in order to keep windage-type losses small, it must be operated within a reduced-pressure casing. It must also be equipped with a system for removing collected particulate matter during operation. The specific centrifuge described is suitable for continuous separation of particles as small as 0.1 μm at a gas throughput of 5 m^3/s. Its operating power requirement is approximately 30 kW.

SIMULATION FOR A SOLAR ENERGY SYSTEM FOR INSECT CONTROL. J. T. Beard, F. A. Iachetta, G. C. Alling, H. J. Manning, Dept. of Mech. and Aero. Engrg., Univ. of Va., Charlottesville, Va.,

A Virginia Academy of Sciences presentation in 1979 described a proposed solar-powered cooling system for an agricultural storage warehouse. The justification for such a system was also discussed.

This paper describes a computer model which was written to simulate the operation of the system. Weather data from Raleigh, N.C. were used to model the system throughout an average year. Results of the simulation are presented and compared to measured data; verifying the accuracy of the model.

The model was used to evaluate and size the important cooling-system parameters such as the collector, refrigerator and latent heat storage tank. The results of this evaluation are presented.

EXPERIMENTAL VIBRATION ANALYSIS OF THE SPACE SHUTTLE MAIN ENGINE HIGH PRESSURE TURBOPUMPS. J. R. Bielk, R. D. Flack*, and E. J. Gunter*. Dept. of Mechanical and Aerospace Engineering, University of Virginia, Charlottesville, VA 22901

For the past three years, the Space Shuttle Main Engine (SSME) has been plagued by high pressure turbopump reliability problems. These problems are caused by high vibration amplitudes in pump operating speed ranges and result in decreased pump seal and bearing life. Vibration data from accelerometers externally mounted on the turbopumps has been analyzed using 1) a tracking filter to obtain plots representing synchronous response versus pump rotational speed, and 2) a Fast Fourier Transform Frequency Analyzer to plot vibration spectrums. These plots have been examined for evidence of fluid whirl in pump seals, pump critical speeds, and the vibrational interaction between the fuel and oxidizer pumps.

Specific conclusions resulting from this experimental work include:

1) The oxygen pump seals may only be marginally stable at the pump running speed corresponding to SSME rated power level.

2) A strong resonance is present in the oxygen pump at the SSME rated power level.

3) Hydrogen pump 1st and 2nd critical speeds occur at 16,500 and 33,000 RPM.

4) Internal rotor behavior cannot always be accurately determined through use of externally mounted instrumentation.

DESIGN OF CAPSULES FOR IRRADIATION OF REACTOR PRESSURE VES-
SEL STEELS IN THE UNIVERSITY OF VIRGINIA REACTOR. C.A.Bly*,
J.L.Kelly* and B.L.Shriver. Dept. of Nucl. Engineering &
Engineering Physics, Univ. of Va., Charlottesville, Va.
22901.
    Fast neutron damage to reactor vessel steels is known to
result in reduced ductility which may increase in the possi-
bility of brittle fracture.
    In support of a study of the mechanisms by which fast neu-
tron irradiation damages steels, an irradiation capsule and
holder has been designed which allows precise determination
and control of the neutron flux and specimen temperature
during irradiation. Design calculations involved a coupled
analysis of radiation attenuation and its attendant heating,
additional heating supplied by resistance heaters, and heat
transfer and fluid flow which apply to the capsule geometry.
    Systems engineering considerations included component re-
liability and availability, and the requirement that the de-
sign remain within the fabrication capabilities of our mac-
hine shop. A "dummy" capsule has been used to assure all
design criterion were satisfied.
    This design could serve as a prototype of single-fuel
element-sized, irradiation capsules that could be used at
all nuclear research facilities using standard MTR type fuel
elements.

DEVELOPMENT AND TESTING OF PROTOTYPIC BREEDING BLANKETS FOR
FUSION REACTORS. C. S. Caldwell*, R. E. Womack*, J. K.
Schmotzer*, and W. G. Pettus, Lynchburg Research Center,
Babcock & Wilcox Co., Lynchburg, Va. 24505.
    The development of a test design for measurement of
tritium or fissile yields in prototypic fusion reactor
blankets is described. Using neutrons from TFTR, results
can provide early proof of neutronic design methods and
self-sufficiency of tritium breeding, both vital issues for
future toroidal-geometry D-T burning reactors. Tests of a
module in the Tokomak Fusion Test Reactor can provide data
by 1985.
    Functional requirements, and selection criteria for a
lithium oxide array are given. Measurement procedures for
neutron fluence and tritium production are outlined. The
TFTR will produce $\frac{1}{2}$-second pulses of D-T fusion neutrons
(14 Mev) with a flux of 3 to 4 x 10^{12} n/cm^2/sec at the
vacuum vessel wall. The module is rectangular with a
frontal area of 0.4 M^2. The Li$_2$O is contained in Zr tubes
on a tight-packed triangular pitch. Rods can be oriented
radially or vertically, and rod spacing/coolant/reflector/
multiplier combinations can be adjusted for parametric
tests. Diagnostics include dosimetry "rabbits" and strain
gages.
    Neutronics predictions using transport and Monte-Carlo
codes will be compared with profiles of tritium, neutron
fluence, and gamma dosimetry.

TECHNICAL AND NON-TECHNICAL COMMUNICATION PROBLEMS INVOLVED
WITH ENERGY CONSERVATION PROGRAMS. C. A. Conner. Univ. of
Virginia, Charlottesville, Virginia   22901
    This presentation is concerned with the communication
problems involved with the development and conduction of
energy conservation programs dealing with public buildings.
The laws and regulations involved in the development of the
Grants Program for state energy conservation along with com-
munication problems encountered will be studied first. Next,
the energy audit approach and forms developed by the Center
for Energy Analysis for the State of Virginia will be
analyzed with respect to their requirements and weak or
strong communication points. The development and results of
this form will be presented along with the several studies
and surveys of communication problems conducted. Conclu-
sions and recommendations relating the problems and solu-
tions will be presented for the State of Virginia's energy
conservation program.

STUDIES OF FRACTURE IN ADHESIVELY BONDED POLYMER COMPOSITES.
David W. Dwight and Ronald J. Vuz*. Dept. of Materials
Engineering, Va. Polytechnic Inst. and State Univ.,
Blacksburg, Va. 24061
    The principal objective of this study was to develop
methodology to provide useful analysis of the critical para-
meters involved in lap shear failures of reinforced polymer
sheet-molding compounds, adhesively bonded with two-compo-
nent polyurethanes. We employed neutron radiography in an
attempt to study inherent flaws in the glue line. Surface
analytical techniques included X-ray Photoelectron Spectro-
scopy (XPS or ESCA) to determine surface atomic compositions,
and Scanning Electron Microscopy (SEM) to study fracture
surfaces. Also, optical microscopy was used for fractography,
as well as to observe microstructures in cross-sections near
the locus of failure. In this paper we present initial cor-
relations between shear strength, surface analysis, non-de-
structive testing and fractography.

MEASUREMENT INTERMITTENCY CORRELATION USING A LIGHT SCATTER-
ING TECHNIQUE, Codrey Fies, Dept. of Mech. and Aero. Engr.,
U. Va., Charlottesville, Virginia 22901.
    An axisymmetric air jet, coflowing with windtunnel air is
marked with an aerosol. At the same time two volumes some
distance apart but in the boundary regions of the jet flow
are illuminated with different colors of laser light. When-
ever aerosol particles contained in the jet flow pass
through the illuminated volumes light is scattered, render-
ing the jet flow in the volumes visible. This scattered
light is detected by photo diodes. It is then processed
electronically to give measurements of correlation between
the portions of flow bounded by the two control volumes.
These measurements show just over how much time and space
the shape of the boundary between the jet flow and wind-
tunnel flow changes completely.

SOLAR ENERGY IN NORWAY? J. B. Freim*, Babcock & Wilcox
Company, Research & Development Division, Lynchburg, Virginia
    A technical and economic assessment of the use of solar
energy in Norway was performed. The study analyzed active
liquid and air solar systems to provide space heating and
water heating.
    The five Norwegian cities used in the study are Oslo, Ber-
gen, Kise, Trondheim, and Tromso; these cities were selected
because their temperature, sunlight, and wind conditions
differ. The Norwegian Meteorolgical Institute selected a
"typical" weather year for each city; the weather data was
used in the calculations.
    A typical one family house was chosen; seven different in-
sulation standards for this house were investigated. The
Norwegian program, ENCORE (Energy Consumption in Residential
buildings) was used to calculate the heat loads for this
house for the "typical" year.
    Seven solar collectors were used. Three are Norwegian, one
from Germany, and three from the USA. For each collector, a
plot of efficiency as a function of temperatures and solar
insolation is needed.
    The program FCHART, obtained from the Solar Energy Labora-
tory at the University of Wisconsin, was used to determine
collector performance and economics.
    The most interesting results are the following:
        • Good economics for a Norwegian collector
        • Efficient use of solar in northern part of Norway
        • Simplified construction by hanging collectors in the
          outside of buildings

BIPOLE TRAJECTORIES. <u>W. P. Harrison, Jr.</u>, Va. Polytechnic
Inst. and State Univ., Blacksburg, Va. 24061
    A mathematical procedure which can be used to analyze
the motion of north-south bipoles traversing a magnetic
field of distributed flux density is discussed and demon-
strated. An example of X-direction trajectories at constant
height over a flat magnetic sheet with a uniform north
monopole flux density distribution is shown. It is
concluded that the method discussed can be used to analyze
a wide variety of problems involving the motion of bipoles
both far from and in the near vicinity of arbitrarily
distributed flux density fields.

GEOTHERMAL WELL-EARTH COUPLED WATER SOURCE HEAT PUMP SYSTEM
FOR RESIDENTIAL HEATING AND COOLING. <u>F. A. Iachetta</u>, Dept.
of Mech. and Aero. Engr., Univ. of Va., Charlottesville,
Va. 22901
    The earth is used as an energy source-sink for a heat
pump with a buried closed loop water circulating system.
Water circulates in a loop consisting of a horizontal run
of pipe buried two feet below the frost line, combined with
a heat exchanger submerged in a 250 ft. deep well and a
water to Freon 22 heat exchanger which is connected to a
modified heat pump. No water is pumped from the ground
which in effect renders this a geothermal system.
    Seasonal COP of 2.7 to 3.0 is realizable compared to
1.6 to 2.0 for conventional air-air heat pumps. Defrost
and auxiliary heat requirements are eliminated and the
balance point is raised. Energy requirements for the
heating cycle are reduced up to 50% compared to air-air
systems and up to 25% when the system operates in the cool-
ing mode. Power required to circulate water in the earth
coupled loop is 185 watts, substantially below the energy
required to pump water from the ground.

AN ACTIVE DOSIMETRY SYSTEM FOR THE ENVIRONS OF A NUCLEAR
POWER PLANT. <u>W. R. Johnson</u>*, G. C. Carlson*, M. A. Pope*,
D. W. Varney*, Dept. of Nuclear Engineering, Univ. of Va.,
Charlottesville, Va. 22901
    A system has been designed to monitor the area surround-
ing a nuclear power plant with active gamma-ray dosimeters.
The signals from these devices are fed to a central
processor at the plant which will store, process and display
radiation dose information. A novel gamma-ray dosimeter has
been developed which is relatively inexpensive and has a
wide range of linear response in both dose rate ($\sim 10^{-6}$-to-
10 R/hr) and photon energy (0.06 MeV-to-3 MeV). The system
would include 50 to 100 dosimeters in concentric rings
around the plant out to a distance of 1 to 2 miles. During
normal operations the system would perform a routine radi-
ation monitoring and data storage functions. In the event
of an abnormal radioactivity release the system would
automatically shift to the accident mode and notify oper-
ators of higher than normal offsite dose rates. The system
computer would predict population doses and maximum offsite
doses from the dosimeter data, meterological condition
input, and stored site population data. The computer system
can generate estimates of the magnitude of the radiation
release. This information will enhance operator understand-
ing of accident details and provide rapid guidance as to
protective measures to be initiated. The system's output
and diagnostic capability may also be provided in parallel to
a state emergency preparedness office.

DEVELOPMENT OF AN ANALYTICAL MODEL FOR ICE
ACCRETION. <u>R. D. Kirchner</u>. Institute for
Hypersonic Studies, Inc., 7602 Cornwall Road,
Richmond, Va. 23229
    Ice accretion on aircraft surfaces and ice
ingestion in engines can cause significant
degredations in flight performance and catastroph-
ic engine failure. Analytical and numerical
models of the ice accretion process have been
hampered in the past by a lack of understanding of
the density of the accreting ice/air mixture.
    An analytical approach has been developed by
which the density of accreting ice can be pre-
dicted. The approach assumes that impacting water
droplets diffuse through the existing ice struc-
ture according to Fisk's law of diffusion, with
the mass and heat transfer being coupled by means
of the Colburn analogy and the Reynolds analogy
for pipe flow. Nusselt numbers were taken to be a
function of Reynolds number and Prandtl number
according to the accepted techniques of Knudsen
and Katz.
    The ice accretion model was used to predict ice
densities for impacting water droplets with
momenta ranging from 20 to 440 mμ/sec with tem-
peratures varying from -5 to -30°C. Predictions
were found to agree favorably with the experi-
mental results of Macklin.

AN APPARATUS TO DETERMINE THE DIRECTIONAL EFFECT IN THERMAL
CONTACT RESISTANCE AT METALLIC INTERFACES, <u>D. L. Padgett</u>
and L. S. Fletcher, Dept. of Mech. and Aero. Engr., U. Va.,
Charlottesville, VA 22901.
    The resistance to heat flow caused by an interface be-
tween two contacting materials is defined as the thermal
contact resistance. The necessity of knowing exact heat
transfer characteristics in applications such as nuclear
reactors and spacecraft has recently brought increasing im-
portance to this area of study. Thermal rectification is a
directional bias which occurs when heat flows between two
dissimilar metals in contact. Rectification is evidenced
by different contact resistance valves when the heat flow
direction is changed.
    The University of Virginia currently has a project under-
way to investigate thermal contact resistance and thermal
rectification. The first step of this project, to design a
reliable test facility, has been completed. This apparatus
allows the investigation of thermal contact resistance at
higher pressures and temperatures than previously possible,
and it also has the capability to reverse the heat flux
direction to obtain reliable data on thermal rectification.

STAFFING ANALYSIS AND VOLUME EVALUATION - "SAVE" - FOR SMALL
POST OFFICES. <u>L. A. Rowe</u>* and J. P. Saunders*, U.S.P.S.,
Roanoke, VA 24022; and K. P. Bovard, An. Sci. Dept., VPI &
SU, Blacksburg, VA 24061
    For one week in July 1976 data were collected in 18 second
class and 31 third class post offices having similar work
load and community service requirements in the Roanoke area
management sectional center. Using a similarity constraint
that each post office would work only single zip incoming
final destination mail, a multiple regression analysis was
performed. The dependent variable was total office staffing
hours; observed mean 68.1 $\pm$ 30.4 hr. Independent variables,
listed in decreasing order of importance, each preceded by
its partial regression coefficient and followed by its ob-
served mean, resp., were: .0138 X4, incoming mail, 2137.7;
-14.16 X7, class of post office, 2.6; .0454 X6, number of
lock boxes rented, 141.2; -.0182 X3, pieces of mail cancelled
483.9; .0642 X1, number of window transactions, 102.5;
-.1213 X5, hrs. of rural carrier service, 54.1; and, .0041 X2,
outgoing volume by type, 674.7. All but the last were sig-
nificant (P < .10). The Y-intercept was 75.4. The regression
analysis reduced the C.V. from 44.6 to 13.8; P < .001; the
multiple correlation, R, was .957. Results from this study
provide basic and essential information reflecting the pres-
ent state in the art of managing accountability for small
post offices.

COMPUTER-AIDED DESIGN OF AIR CONDITIONING AND HEAT PUMP SYSTEMS. T. C. Scott. Department of Mechanical and Aerospace Engineering, University of Virginia, Charlottesville, Virginia 22901

This paper examines the response of the engineering community to the current demands for more efficient air conditioning and heat pump systems. Past and present design and testing techniques are discussed and evaluated and the extent to which computer-aided design has been incorporated by the industry is reviewed. The areas where research is needed are many, but of more importance is the need for information transfer from researchers to practitioners.

NEUTRONICS CALCULATIONS FOR A PROPOSED PROTOTYPIC BREEDING BLANKET MODULE. F. G. Welfare* and W. G. Pettus. Babcock and Wilcox Company, Research and Development Division, Lynchburg, Va. 24505

For many years the effort in fusion power development has been focused on questions of plasma physics. Recent progress in this area now requires investigation of the engineering questions involved in fusion power systems. One such engineering question deals with the design of fusion blankets which will serve two purposes: (1) converting the energy released into a useful form and (2) breeding fuel either for the fusion system or for other energy systems. This paper presents neutronics calculations for an experimental blanket module which should be prototypic of blankets for power reactors and which is designed for use with the TFTR fusion device. The ability of this module to breed tritium as fuel for a fusion device has been evaluated in an extensive series of calculations. These calculations show that tritium breeding ratios in the neighborhood of 1.45 are obtainable. The spatial variation of the tritium yielding reactions has also been calculated as has the ability to breed materials other than tritium.

Environmental Science

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

ENVIRONMENTAL PERCEPTIONS, RECREATIONAL BEHAVIOR, AND MANAGEMENT PREFERENCES OF LAKE PROPERTY OWNERS. L. A. Helfrich*, M. B. Bain*, and D. L. Weigmann*. Virginia Polytechnic Institute and State Univ., Blacksburg, VA 24061
    This study was designed to provide a basic understanding of lake property owners and their potential role in formulating lake management policies. A 50-item mail questionnaire was used to collect data on the characteristics, recreational use patterns, perceptions and preferences of lake property owners.
    Solitude, natural beauty, economic considerations, and water-based recreational opportunities were the principal reasons cited for lake property ownership. Swimmers comprised the largest and most active user group. The subjective assessments of lake shore residents concerning various attributes of water quality, shoreland development, neighborhood conditions, and recreation pressure, accurately reflected the prevailing environmental conditions based on objective limnological measurements. Our respondents' selection of management activities were directly related to their environmental perception and appropriate for the existing conditions. Lake property owners were particularly sensitive to water clarity, sedimentation and erosion problems, strongly supported most proposed management activities, and appeared willing to restrict their recreational activities to protect environmental quality.

EFFECTS OF ARSENATE ON ALGAE, DAPHNIA, AND MOSQUITO FISH. S. Jurewicz* and A. L. Buikema, Jr. Dept. of Biology Va. Polytechnic Inst., Blacksburg, Va. 24061.
    Toxicity tests, using sodium arsenate, were performed on Chlamydomonas reinhardii, Daphnia pulex, and Gambusia affinis. The algal test was adapted from the EPA method. The animal tests were static without renewal, and conducted at 20±2°C., and a 16L:8D photoperiod. The 14 day 50 and 95% inhibition of algal growth (95% f.l.) were 202 (197-206) and 264 (254-278) mg/l, respectively. Stimulation of biomass occurred up to 151 mg/l, with maximum stimulation averaging 73% above controls at 100 mg/l. The mean cell diameter and variability of diameters increased as concentration increased. Also, at the higher concentrations, a greater proportion of cells had an enlarged gelatinous muscilage, were nonmotile, and lacked flagella. The 24 and 48 hr LC50s (95% f.l.) for Daphnia were 10.3 (6.6-14.0) and 3.6 (3.3-3.9) mg/l, respectively. Individuals were nonmotile up to 8 hrs before death. The 48 and 96 hr LC50s (95% f.l.) for Gambusia were 57 (51-64) and 49 (44-54) mg/l, respectively. Loss of equilibrium, lack of motility, and hemorrhaging of the gill and opercular region were observed.

SURFACE CIRCULATION AND HORIZONTAL DIFFUSION PROCESSES OF THE LOWER CHESAPEAKE BAY. R.E. Johnson and F.A. Hilder*. Dept. of Oceanography, Old Dominion University, Norfolk, VA 23508
    A Langrangian method utilizing clusters of four or five buoyed drogues is used to study the surface circulation and horizontal diffusion. The study area in lower Chesapeake Bay encompasses some 160 km² and includes the area north of Thimble Shoal Channel, southwest of Chesapeake Channel and west of the Chesapeake Bay Bridge and Tunnel.
    The surface current is seen to be of a rotary type which is not inconsistent with a tidally dominated wide estuary where Coriolis force can be significant.
    The horizontal diffusivity, as represented by Richardson's neighbor diffusivity concept, appears to confirm the applicability of the "4/3 power law" to the study area.

VIRGINIAN SEA PLANKTON ASSEMBLEDGES AND THEIR RELATIONSHIPS TO SHELF-SLOPE WATER MASSES, 1978-1979. C. E. Meyer* and H. M. Austin, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia 23062.
    The shelf and slope water masses on the Continental Shelf of the southern Virginian Sea can be delineated by their planktonic and physical characteristics measured by Continuous Plankton Recorder (CPR) and Expendable Bathythermograph (XBT) transects on USCG cutters. Shelf waters are differentiated from slope waters by year round higher standing crops of phytoplankton and zooplankton. Phytoplankton species diversity is higher in shelf waters year round while dominant zooplankton diversity shifts between shelf and slope waters seasonally. The water masses can also be differentiated by dominate copepod species less than 2.0mm. Shelf waters support principally, Para-pseudocalanus and Centropages typicus while slope waters support Pleuromamma, Oncaea, and Oithona.
    The vertical seasonal thermal structure and surface salinities indicate the position of the shelf-slope front by changes in the inclination of the isotherms and surface salinity gradients (shelf < 33 o/oo, slope > 35 o/oo).

THE DISTRIBUTION OF CS-137 AND SOME HEAVY METALS IN VARIOUS SEDIMENTARY ENVIRONMENTS OF THE JAMES RIVER ESTUARY. C.S. Moy*, G.T.F. Wong*. Dept. of Oceanography, Old Dominion Univ., Norfolk, Va. 23508

The concentrations of Cs-137 and several heavy metals were measured in sediment cores taken from a variety of sedimentary environments of the James River Estuary. The sedimentation rates range from 2 to 18 mm/yr as determined by the distribution of Cs-137. Sediments in a low energy environment (Burwell Bay) contains the highest percentage of fine grain material (<63μm) and the highest concentrations of Cs-137 (∿2pCi/g). In higher energy environments (Point of Shoals, Rocklanding Shoal Channel and Warwick River), the sediments contain 15-95% of fine grain material depending on the amount of oyster shell debris and lower concentrations of Cs-137 (<1pCi/g). The vertical distribution of Cu is fairly constant (∿50μg/g). The concentrations of Zn (50-250μg/g) vary with concentrations of Cs-137.

THE TEST-BED AIRCRAFT MULTISPECTRAL SCANNER. Weldon Staton* NASA Langley Research Center, Hampton, Va. 23665.

In recent years, NASA Langley has been engaged in remote sensing of the marine environment using airborne optical scanners. About a year ago, NASA Langley embarked upon the task of building a multichanneled scanner to be used as a research tool in marine applications. This tool is an instrument called the Test-Bed Aircraft Multispectral Scanner (TBAMS). The instrument can be used for land as well as marine studies. Forests, grasses, and crops can be mapped, in addition to phytoplankton and suspended sediment.

The TBAMS instrument consists of nine spectral bands, eight which include visible and near infrared and one infrared. Design of the system is such that research flexibility is achieved. The rationale behind the development of the TBAMS instrument will be presented. Examples of data acquired with the system will also be presented.

A STUDY OF THE FIRST THREE MONTHS OF THE PRIMARY SUCCESSION OF ADAM'S LAKE. Carolyn L. Thomas, Barry G. Hughes*. Dept. of Biology, Ferrum Col., Ferrum, Va. 24088

The purpose of this study was to do a limnological survey of the first three months of the primary succession of Adam's Lake on the Ferrum Col. Campus. It was tested for its dissolved oxygen content, water temperature, turbidity, pH, nitrate and orthophosphate content, zooplankton, and phytoplankton. Representative samples taken from various sites demonstrated the fluctuations of the different tests.

Results of the study showed how the integration of factors in an aquatic system determine its productivity. There are numerous cause and effect relationships in such a system. Some factors seemed to be influenced by this integration, while others were independent.

CORRELATIONS BETWEEN CLIMATOLOGICAL FACTORS AND THE COMMERCIAL BLUE CRAB CATCH IN CHESAPEAKE BAY. W. A. Van Engel, and R.E. Harris, Jr.*. Va. Inst. Mar. Sci., Sch. Mar. Sci., Col. William and Mary, Gloucester Point, Virginia 23062.

Climatological factors immediately preceding spawning and in the first eight months of life of blue crabs (Callinectes sapidus) are major factors in establishing the ultimate population size, as measured by the Chesapeake Bay commercial catch. Monthly values of climatological and environmental data were lagged up to 24 months prior to the Biological Year catch, the sum of monthly landings from September through August. Correlation coefficients between 20 variables and the catch were larger than ± 0.58, and significant at the 0.025 percent level (one-tailed test). Cooling degree days at Norfolk Airport (May 2, r=0.77), meridional wind stress and zonal Ekman transport at Cape Hatteras (both in Sept. 2, r=-0.65), water salinity at Kiptopeke Beach (Oct. 1, r=0.64), and Chesapeake Bay streamflow at the mouth of the bay (Oct.1, r=-0.64) were the events most highly correlated with catch but not co-correlated. The notations May 2, Sep. 2 and Oct. 2 refer to the month and the number of Biological Years preceding the catch.

REPETITIVE AERIAL PHOTOGRAPHY FOR ASSESSING MARSH VEGETATION CHANGES. M.G. Weaver*, G.H. Cross, and R.A. Mead*. Schl. of For. & Wildl. Res., Va. Polytechnic Institute, Blacksburg, Va. 24061

The dynamic conditions of two marshes on the Rappahannock River, Virginia, were investigated using sequential aerial photography. All the historical photography was 9 inch format, black and white panchromatic, medium scale, purchased from various government agencies. Recent photos were large scale 35mm color infrared and natural color postive transparencies. Vegetative classes were delineated on the recent photographs to produce a large scale 1:2500 map useful in current resource planning and future monitoring. The black and white historical photos were interpreted using a generalized classification system. Comparisons of changes were made by reducing the current vegetation classes to a common scale of 1:7000. In addition, muskrat lodges were plotted on all photographs where resolution and quality permitted. Repetitive aerial photographs provided useful information on which to formulate hypotheses that would explain changes in marsh vegetation.

A STUDY OF CLIMATE CHANGE IN SOUTHEASTERN VIRGINIA FROM 1933-1977 USING THE THORNTHWAITE INDICIES OF CLIMATE CLASSIFICATION. S. M. Zubrick* and N. Aldridge*. Dept. of Geophysical Sciences, Old Dominion Univ., Norfolk, Va. 23508

Using a modified Thornthwaite evapotranspiration formula within a water budget model, monthly actual evapotranspiration values were derived for six Southeastern Virginia stations over a forty-five year interval. The computer program yielded annual values of the Thornthwaite indicies of climate classification for the six sites. It required only the monthly precipitation, mean temperature, and estimates of soil water-holding capacity for each location.

A qualitative correspondence among the six stations in the pattern of climate change was revealed using this classification system.

Geology

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POST-YORKTOWN TIDAL DEPOSITS IN THE UPLANDS OF JAMES CITY COUNTY, VIRGINIA. C. R. Berquist, Jr. and K. W. Ramsey*. Va. Div. of Mineral Resources, c/o Dept. of Geology, College of William and Mary, Williamsburg, Va. 23185
Numerous localities within the central part of James City County, Virginia have provided excellent exposures of the Yorktown Formation (Early Pliocene) and the overlying upland sediments. These uplands were formed in tidal environments and consist of tidal channel, tidal flat, and lagoonal deposits. They are thought to represent a Late Pliocene to Early Pleistocene barrier island-estuarine system which deposited material when sea level was greater than 50 feet.

LARGE QUARTZ CRYSTALS FROM ROCKINGHAM COUNTY, VA. Barry W. Miller*, James L. Beaver, Jr.*, F. H. Campbell III, Dept. of Geology, James Madison Univ., Harrisonburg, Va. 22807
In April 1979, a number of unusually large, singly terminated quartz crystals were found associated with the Beekmantown Dolomite in Rockingham County. The crystals were initially noticed in rock piles in a wooded ravine along the Shenandoah River. No large crystals were found in situ or associated with matrix material; however, a float specimen of breccia was found which consisted of saccharoidal dolomite fragments enclosed by veins of white, crystalline dolomite. Within a cavity on this specimen are moderate-sized milky quartz crystals growing over small, gray, rhombohedral crystals of dolomite. Several mineralized collapse breccias in this area are believed to have formed as a consequence of activity along the nearby North Mountain thrust fault. Three potential sources of silica exist within the Beekmantown; and numerous rhombohedral impressions are found on many of the large quartz crystals. This suggests that these crystals formed in a mineralized collapse breccia.

A RECONNAISSANCE STUDY OF THE GEOLOGY OF THE SOUTHERN HALF OF THE RICHMOND BASIN, VIRGINIA. Bruce K. Goodwin, Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185.
South of latitude 37°30', Upper Triassic sedimentary rocks of the Richmond Basin occur within the Hallsboro, Clayville, Winterpock, Mannboro, Church Road, and Hebron 7½' quadrangles. Four mappable rock units occur here: (1) coarse conglomerates; (2) coal measures, including lower barren beds; (3) light to dark gray, dominantly lacustrine, sandstone and shale; and (4) reddish fluvial sandstone. Total thickness of the Triassic rocks is unknown but may exceed 4,000 feet. One deep drill hole has shown that the reddish sandstone, previously thought to be only 500 feet thick, is over 1,500 feet thick. Massive conglomerates occur locally along the basin's margin adjacent to faults. Coal measures lie unconformably upon the basement complex along the northern and southern segments of the basin's eastern margin. The coal measures are absent in a complexly faulted central area of the eastern margin, and have not been found on the basin's western margin in the area of this study. The basin is usually bounded on its western side by normal faults and that border may be step faulted. In general, bedding strikes north northeast and dips gently westward across most of the basin. Local reversals of dip and deviations of strike delineate some flexures and suggest faulting within the basin. Near faults along the basin margins, bedding often strikes parallel to the faults and dips in toward the basin.

1300 MILLION YEAR OLD ROCKS IN EASTERN NORTH AMERICA. Douglas Mose and Susan Cohen*, Dept. of Chemistry and Geology, George Mason University, Fairfax, Va. 22030
U-Pb and Rb-Sr age determinations from Precambrian rocks in the Grenville Province of eastern North America have revealed the presence of 1250 to 1350 m.y. old rocks in an area generally considered to be composed of rocks less than 1150 m.y. old. Reported data include 1280 m.y. old gneisses in Pardee Point, Tennessee (Davis and others, JGR, 1962), 1225 m.y. old Cranberry Gneiss in North Carolina (Fullagar and Odom, GSA Bul., 1973), 1300 m.y. old Baltimore Gneiss in Maryland (Tilton and others, Studies of App. Geology, 1970), and 1350 m.y. old Adirondack rocks in New York (Spooner and Fairbairn, JGR, 1970). New data on the Fordham Gneiss in the Manhattan Prong and the Reservoir Granite in the Reading Prong, both in southeastern New York, and new data from two areas in the southeastern Adirondacks of upstate New York show that the Manhattan Prong, Reading Prong and Adirondacks contain 1300 m.y. old rocks. Present studies are concentrating on the mechanism by which radiometric "clocks" responded to the widespread 1000 m.y. old Grenville metamorphic event.

GEOLOGICAL CONSERVATION PROBLEMS OF CAVES AND ASSOCIATED KARST AREAS OF VIRGINIA. Roy D. Powers* Mining and Technology Division, Mountain Empire Community College, Big Stone Gap, Va. 24219

Over the past few decades as the growth rate of Virginia and her neighboring states has increased, the conservation problems concerning caves and associated karst areas have risen to a high level. Population pressure has caused an overloading of many karst areas resulting in severe damage to the geology of these areas.

Problems associated with this population growth include groundwater pollution, indiscrete refuse dumping, wanton vandalism, formation mining, and destruction resulting from highway and dam construction.

A complex network of various organizations has evolved to help combat these problems.

TECTONIC AND GEOMORPHOLOGIC IMPLICATIONS OF JOINTING IN BRUSH MOUTAIN, MONTGOMERY COUNTY, VIRGINIA. Noel G. Simmons*, Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

The Price Formation of Brush Mountain forms the major structural front northwest of the Pulaski overthrust sheet. The stratigraphy (Kreisa & Bambach, 1973) consists of a basal Cloyd Conglomerate, which is the primary ridge-former, and an overlying non-marine cyclic sequence of terrigenous sandstones and mudstone. The Merrimac Coal seam is a member of this formation.

Northeastward from New River, the formation strikes linearly for 2 1/2 miles after which the mountain develops a broad "s"-shaped curvature before returning to a nearly linear ridge farther northeast. Resequent streams have incised the Price, and from the differential weathering of the cyclic sandstones and mudstones produced cusp-shaped secondary ridges disposed regularly along the southeast flank of the mountain. The formation is cut by extensional normal faults as described by Kreisa (1972) as well as prominent joints.

The joints were mapped and plotted by means of a stereo-net to determine whether they are the products of Pulaski overthrusting and to see if there is a relationship between jointing and the unusual curvature of Brush Mountain.

STRATIGRAPHIC VARIATIONS OF THE SILURIAN SYSTEM IN THE CATAWBA SYNCLINE, ROANOKE AND MONTGOMERY COUNTIES, VIRGINIA. Robert R. Seal, II*, Dept. of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

The doubly plunging, northeast trending Catawba syncline of the Pulaski overthrust sheet exhibits striking strati-graphic variations of the Silurian System. The variations are typified by two localities 17 miles apart. The first near Catawba along Virginia Route 311 is 3 miles up the northwest limb from the trough and depression of the syn-cline, and the second at Fagg is in the trough at the south-western nose of the syncline. The Silurian section along 311 is approximately 300 feet thick beginning with 20' of clean conglomeratic Tuscarora Sandstone, followed by 75' of hematitic Rose Hill sandstone and interbedded shale, in turn, overlain by 175' of moderately clean, cross-bedded Keefer Sandstone. At Fagg, the entire Silurian section is re-presented by only 5 1/2' of Tuscarora-like conglomeratic sandstone, bounded by unconformities.

These stratigraphic variations can be attributed to differential axial subsidence during Silurian time of the Catawba syncline, the first major downwarp northwest of the Blue Ridge anticlinorium.

GEOTECHNICAL ASPECTS OF THE CHIMBORAZO PARK SLIDE, RICHMOND, VIRGINIA. Ronald J. Tucker, Virginia Department of Highways and Transportation, P. O. Box 391, Petersburg, VA 23803

Historic Chimborazo Park in Richmond, Virginia, situated on a terrace overlooking the James River, has been plagued by landslides for over 70 years. A serious slide in January 1978 that forced the temporary closing of Route 60, led to the present investigation and to remedial efforts at permanently controlling the situation. A grid work of hollow-stem borings were made that provided detailed in-formation on soil types and moisture content and provided undisturbed soil samples for tri-axial testing in the laboratory. Additionally, slope inclinometer casing was in-stalled and data obtained at regular intervals.

Evaluation of the data led to the conclusion that the problem resulted from an already unstable slope that was further weakened when prolonged rainfall added ground water at a rate faster than could be dissipated through the soil. This led to an increase of hydrostatic pressure which con-sequently reduced the shear strength of the soil.

From several alternatives, it was decided the most economical approach would be to control ground water through the use of a horizontal drain system. Sixteen drains were installed a total length of 3700 feet. The drain system is discharging ground water at rates ranging from 32 to 41 gallons per minute and can be correlated closely with rain-fall in the area. To date, the drains have stabilized the slope and further movement has not been detected.

ENVIRONMENTAL INFORMATION AVAILABLE FROM TOPOGRAPHIC MAPS H. W. Webb, Jr., Va. Div. Mineral Resources,Charlottesville, VA 22903.

Topographic maps portray a variety of information useful for environmental planning. Because of reduced field data gathering time and of state-wide coverage map inspection is quite cost effective. Maps of growth areas are revised each five years keeping them up to date. Present and future land uses are influenced by natural environmental factors deriv-able from these maps. Existing use as classified by the U. S. Geol. Survey can be determined for most of Level I and some of Level II. Future use can depend on landforms, drain age, geographic aspect, restricted use, transportation net-work, recreation, & growth direction factors. Landforms can have gentle, steep, or dissected slopes. Drainage divides and floodplains are important for construction and pollut-ion studies. North-facing slopes are usually cooler and wetter with south-facing generally hotter and drier, Milit-ary reservations and cemetaries denote restricted land-use. Roads, railroads, pipelines, and transmission lines indicate the transportation network. Public-use recreation areas are usually designated. Map names are often historical keys. Terrain conditions influence the siting of communication towers. Geologic information combined with topographic data can be used to locate unstable areas such as debris, fans, landslides, & rockfalls.

THE RICHMOND TRIASSIC BASIN: AN INTEGRATED GEOLOGICAL/ GEOPHYSICAL STUDY. Gerald P. Wilkes, David K. Lasch*, Mary T. Stroh*. Va. Div. of Mineral Resources, Charlottesville, Va. 22903

During the summer of 1978 gravity surveys were completed across the Richmond Triassic Basin on US 6, US 60 and US 360 with an additional survey traversing the Deep Run Basin on US 250. All surveys crossed the Triassic sediments nearly perpendicular to their strike. Station spacing was one-quarter mile in the Richmond Basin and 400 feet across the Deep Run Basin. Density values for gravity modeling were obtained from appropriate core, outcrop and quarry samples. Straight-line sections were constructed for each survey. By incorporating gravity data with geologic cross-sections, hypothetical two-dimentional gravity models were constructed.

The study implys that faulting controls the depth to base-ment within the basins. This is a result of a series of horst and graben blocks. A major fault forms the western border of each basin. The maximum depths found are located in the western portion of each basin. Also, the frequency of large basement faults decreases from north to south. This can be partially verified, on the eastern margin, by past mining activity and elsewhere through existing regional gravity and magnetic data.

Materials Science

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
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Fatigue Crack Growth Simulated in Weld Microstructures
D. M. Abel, M. R. Louthan, Jr., R. D. Sisson, Jr., and
R. P. McNitt, College of Engineering, VPI, Blacksburg, VA.

Fatigue crack growth rates in various microstructures simulating regions of the heat affected zone in mild steel welds were determined from tests of compact tension samples. Crack growth occurred during cycling to a constant maximum load thus to an increasing stress intensity, K. Crack lengths were determined from external measurements, heat tinting and compliance calibrations and graphs of crack growth per cycle (da/dn), versus ΔK were developed. Cycling was continued until crack growth caused the applied stress intensity to produce overload failure. Crack growth rates were highest and overload stress intensities were lowest in the base metal thus showing that, in the absence of adverse environmental effects, the heat affected zone of a weld should be less sensitive to fatigue damage than the base metal.

PRELIMINARY ATTEMPTS TO DETERMINE THE AXIAL THERMAL CONDUCTIVITY OF SMALL POLYMER FIBERS. Larry J. Adams* and R. E. Barker, Jr., Materials Science Dept., Univ. of Va., Charlottesville, Va. 22901.

Even under ideal circumstances certain difficulties may be encountered in measuring the true thermal conductivity perpendicular to the surface of a polymer film. The difficulties are greatly magnified when it is desired to determine the anisotropic conductivities in a small fiber or thin fibrillous film. However this is a frequently occurring situation and it would be valuable to have a technique capable of overcoming the formidable problems. Among other merits, such a technique would make it possible to determine the axial conductivities $K_{||}$ of small amounts of newly synthesized fibrous materials. Such a technique also would have important theoretical implications with regard to the effect of fiber size relative to dominant phonon wavelength. For these and related reasons we are investigating methods that may make possible the determination of $K_{||}$ and $K_{\perp}$ for small fibers. (Funded by Airforce Office of Scientific research, Grant No. AFOSR-80-0014)

THE MELTING TEMPERATURE OF TIN MICROCRYSTALS EMBEDDED IN CARBON. G. L. Allen*, W. W. Gile, and W. A. Jesser, Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901.

In the TEM study of the melting point of small metal particles in the size range 10 to 60nm, it is important to limit specimen oxidation. A popular method is to deposit specimens in situ in ultra high vacuum. An alternative method involves deposition of metal particles between two layers of an amorphous carbon "sandwich." This allows the specimen to be transferred in air with minimal oxidation.

Experimental results employing the latter technique show a bulk melting point elevation of about 12°C for tin crystallites. For the model of an elastically constrained specimen enclosed in a bulk matrix, an elevation of about 8°C is calculated from thermodynamic considerations. Equivalent results are calculated for the alternate model of a crystalline metal sphere surrounded by a continuous inert shell. As long as the metal-to-carbon bond is strong, these models predict a melting point elevation regardless of the sign of the particle volume change on melting. (Financial aid by the Army Research Office is gratefully acknowledged.)

HELIUM ION PRODUCED BLISTERING & EXFOLIATION PHENOMENA IN 316 STAINLESS STEEL. James Bennetch and W. A. Jesser, Materials Science Dept., Univ. of Va., Charlottesville, Va. 22901.

Helium ion induced blistering and exfoliation (at 80keV ion energy) of annealed 316 type stainless steel were produced in-situ inside an HVEM. In these HVEM studies, blister caps are defined as being domed in contrast to exfoliation caps, which are flat. Experimental variables included irradiation temperature (up to ~650°C), ion flux (up to ~2 x 10^{15}cm^{-2}sec^{-1}) and ion dose (up to ~4 x 10^{18}cm^{-2}). In addition, some irradiated specimens were subsequently annealed at 900°C for ~1 hour in a high vacuum to produce blister caps. A number of new significant observations concerning these two types of events were recorded. First, the ratio of the radii of curvature, R, of blister caps to their diameters, D, was found to be a constant (R/D = 3.3) independent of temperature and cap diameter. A critical lateral stress, σ_{crit}, for blister cap formation was calculated: at 650°C, σ_{crit} = 790Pa(115kpsi) = 4.8σ_{yield}. In addition, no sudden large scale coalescence of bubbles prior to blister formation was observed; instead, the diameter of bubbles under a blister cap area grew as $(n.t)^{3.4}$ at 650°C, where n = dose and t = time. Finally, a calculation of the number of ions that could be contained in equilibrium bubbles under each type of cap revealed that blister cap bubbles were probably overpressurized. (Research sponsored by Office of Fusion Energy)

TECHNIQUES FOR THE MEASUREMENT OF THE AXIAL ELECTRICAL CONDUCTIVITY OF POLYMER FIBERS. D. Y. Chen*and R. E. Barker, Jr., Materials Science Dept., Univ. of Va., Charlottesville, VA. 22901.

Certain evidence indicates that an extended chain ("rod-like") polymer, such as a polybenzo-bisthiazole, will have a larger electrical conductivity along its chain direction than along other directions. Efforts to study electrical anisotropy in fibers and fibrilose films often encounter extreme difficulties when the level of conductivity is low. Many factors contribute to the difficulty, among them: the small cross-section of a fiber, electrostatic shielding, electrode contacts, etc. In this paper, a number of techniques for determining the anisotropic electrical properties are discussed. Furthermore there is an intrinsic importance in techniques capable of yielding values for the transport properties of small fibers. (Funded by Airforce Office of Scientific Research, Grant No. AFOSR-80-0014)

MEASUREMENT OF ROTOR TEMPERATURE DURING ELECTRICAL BRUSH TESTING. S. A. Dillich, C. M. Adkins, and D. Kuhlmann-Wilsdorf, Dept. of Materials Science, Univ. of Va., Charlottesville, VA 22901.

A novel method for measuring the temperature of rotating or moving machinery parts has been developed and tested. A temperature measurement assembly was used inside a brush testing chamber for the accurate measurement of slip ring (rotor) temperatures during silver graphite (SG 142, 75 w/o Ag 25 w/o C) electric brush tests. Additionally, a new simple method of cooling brushes during testing was devised consisting of a squirrel cage fan rigidly connected to the rotor. The efficiency of the new cooling system was evaluated using rotor temperature measurements during brush testing. It was observed that silver graphite brushes displayed reduced electrical losses apparently as a unique function of rotor temperature. Analysis of the data suggests that the film resistance at the interface is controlled by a Cu_2O layer which exhibits electrical resistance behavior characteristic of a semiconductor with an energy gap for intrinsic current conduction of 1.7 ev. (Funded by Office of Naval Research, Arlington, Va.)

THE MECHANISM OF NEUTRON IRRADIATION ENRICHMENT OF LIGHT WATER REACTOR VESSEL STEELS. O. Hodgins and B. Shriver, Dept. of Nuclear Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22901.

The exposure reacted pressure vessel steels to fast neutrons is known to result in reduced ductility and increase the possibility of brittle fracture. Due to safety considerations, limits are placed on the operation of nuclear power plants in order to ensure that brittle failure of the reactor vessel does not occur.

This study will provide data to help elucidate the mechanism of neutron embrittlement and the effects of variations in the irradiation environment, such as neutron flux and irradiation temperature. Both representative steels and simple model alloys, such as Fe-Cu-C, will be considered. To better determine the mechanism of em-brittlement, microscopic analyses will be used. These analyses will include electron microscopy, low angle neutron and gamma scattering techniques and x-ray micro-analysis.

The research project and results to date will be dis-cussed. This work is supported by the Electric Power Research Institute.

Hydrogen Effects on the Flow Characteristics of Austenitic Stainless Steels D. L. DeHart, M. R. Louthan, Jr., R. P. McNitt and R. D. Sisson, Jr., College of Engineering, VPI, Blacksburg, VA.

The flow curve of austenitic stainless steels in the region of uniform plastic deformation can be expressed by the Ludwik model, $\sigma = K\varepsilon^n$. The yield and ultimate stresses and ductility of many austenitic steels are affected by hydrogen, thus it was expected that the strain hardening exponent could be affected by hydrogen exposure. This work has shown that the effects of hydrogen on the flow curve are dependent on composition of the steel. An 18-8 steel with low carbon (308) was shown to have the strain hardening exponent and ductility decreased by hydrogen exposure. A 25-20 steel containing high carbon (310), exhibited no hydrogen induced change in the mechanical behavior. These results are discussed in terms of hydrogen effects on the micro-plasticity of austenitic stainless steels.

Stress Corrosion Cracking and Hydrogen Embrittlement of Type 310 Stainless Steel C. L. Greene, R. D. Sisson, Jr., R. P. McNitt and M. R. Louthan, Jr., College of Engineering, VPI, Blacksburg, VA.

Stress corrosion cracking in austenitic stainless steels in $MgCl_2$ solution has been proposed to be either a hydrogen embrittlement phenomena or an anodic dissolution process. Type 310 stainless steel is both embrittled by hydrogen and susceptible to stress corrosion cracking, thus a series of tests were conducted to determine if precharging with high pressure gaseous hydrogen would increase the susceptibility to stress corrosion. Time-to-failure versus applied stress data were collected for wire samples tested on $MgCl_2-H_2O$ solutions boiling at 150°C. Hydrogen pre-charging altered the time-to-failure data thus supporting the hypothesis that hydrogen uptake plays a major role in stress corrosion processes.

Storage of Hydrogen in $LaNi_5$ B. Lewis, J. Murali, R. P. McNitt, R. D. Sisson and M. R. Louthan, Jr., College of Engineering, VPI, Blacksburg, VA.

The use of hydrogen in energy storage systems is cur-rently under extensive study due to the abundance and acces-sibility of hydrogeneous compounds. Practical means of storing hydrogen include the reaction of hydrogen with a metal or alloy to produce a hydrogen saturated "hydride" phase. Certain metallic compounds readily absorb quantities of hydrogen which exceed the amount of hydrogen which could be stored in an equivalent volume as either solid or liquid hydrogen. Thus, energy can be efficiently and compactly stored in the metal lattice. An experimental investigation of the absorption and desorption characteristics of hydrogen from $LaNi_5$ was conducted. The basic theory associated with the hydriding phenomenon is summarized, and the performance characteristics of $LaNi_5$ during successive hydriding/de-hydriding experiments are presented and compared with typical data already published for this particular alloy.

THE LOCATION OF ZN IN DENTAL AMALGAM. <u>Manuel C. Mejia</u> and Dr. L.B. Johnson. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

Previous work has shown that a very small amount of Zn, 3 to 5 atomic percent, has great effect on the physical properties of dental amalgam. For example, the addition of 5 atomic percent Zn to Ag_3Sn increased the compressive strength by about three times and decreased creep by about the same amount.

It was believed that the Zn was located in a strategic position to have such a large effect. This research was undertaken in an effort to determine the specific location of the Zn.

Cylindrical samples 8 mm long and 4 mm in diameter were prepared according to ADA specifications. The alloy used contained 71% Ag, 24% Sn, and 5% Zn. The specimen were polished with SiC paper down to 600 grit and with diamond paste down to $\frac{1}{4}$ micron particles. The samples were coated with vapor-deposited carbon and observed in the SEM.

Secondary electron imaging (SEI) and backscattered electron imaging (BEI) in conjunction with energy dispersive X-ray analysis were used to localize the Zn. Two types of SEM's and X-ray analyzers were used to cross-check the results

It was concluded that the Zn occurred in almost elemental form at the boundaries between the $\gamma_1 (Ag_2Hg_3)$ and γ_2 (Sn_8Hg) phases.

PRELIMINARY INVESTIGATION OF THE HIGH-TEMPERATURE STRENGTH CHARACTERISTICS OF POLYCRYSTALLINE STEEL WHISKERS ALLOYED WITH CHROMIUM. <u>Thomas M. Moore</u>* and H. G. F. Wilsdorf, Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901.

Steel polycrystalline whiskers (Schladitz Whiskers) are high-strength fibers produced by Chemical Vapor Deposition from the thermal decomposition of iron carbonyl in an applied magnetic field. These whiskers are characterized by a primary grain size on the order of 100Å and tensile strength of up to 8 GPa (1.2 MPSI). A process has been developed for alloying the whiskers during growth with chromium over the entire composition range. The hardness of these alloyed whiskers after a brief heat treatment characteristic of that involved in incorporation of these fibers into a metal matrix composite was studied. A definite resistance to softening was observed but at a higher chromium composition than expected. Also, insights into the whisker growth process were obtained. (This work was supported by a grant from the Office of Naval Research)

Use of Metal Hydrides as a Heat Pump <u>S. M. Milkovich</u>, M. R. Louthan, Jr., R. D. Sisson, Jr. and R. P. McNitt, College of Engineering, VPI, Blacksburg, VA.

Metal hydrides have the ability to absorb and release large quantities of hydrogen many times without significant deterioration. When a metal hydride absorbs hydrogen, the resulting reaction is exothermic. In turn, when the hydrogen is given off, the de-hydriding reaction is endothermic. By coupling the exothermic and endothermic reactions and repeating them in cycles, an effective heat pump can be developed. The thermodynamic and kinetic properties of these reactions were studied and used to develop the design of a workable heat pump.

Solubility and Diffusivity of Hydrogen in AISI 1015 Steel <u>J. Murali</u>, Burt Holmes, M. R. Louthan, Jr., R. D. Sisson, Jr., and R. P. McNitt, College of Engineering, VPI, Blacksburg, VA.

The solubility and diffusivity of hydrogen in 1015 steel were investigated. Both gaseous and electrolytic hydrogen charging techniques were used to expose sample membrances approximately 0.04 cm thick and 7 cm in diameter. In the gas phase charging experiments the sample membranes were exposed to purified hydrogen at various pressures for times long enough to cause saturation. Hydrogen outgassing parameters were then measured by sensitive electrochemical techniques. The electrolytic hydrogen charging measurements were made during the rise to and decline from steady state permeation experiments conducted at various input current densities. The results are compared to the literature data and show the effect of trapping on the solubility and diffusivity of hydrogen. Correlations between electrolytic charging measurements and gas phase hydrogen exposures are also presented.

ANALYSIS OF COMPOSITION PROFILES WITH A TIME DEPENDENT SURFACE CONCENTRATION. <u>V. B. Rao</u> and C. R. Houska, Dept. of Materials Engr., Va. Polytechnic Inst. and State Univ., Blacksburg, VA. 24061.

An approximate iterative solution has been used to determine composition dependent diffusion coefficients of one-dimensional diffusion zones with a time varying surface composition. It was found that the surface composition could be described by a simple exponential function of time for the Al-Ti system. The composition profile was obtained from an analysis of the (101) α-Ti x-ray diffraction intensity band. Diffusion zones extending from a few tenths to several microns have been examined.

MODIFICATIONS IN THE X-RAY LINE SHAPE ANALYSIS. <u>T. M. Smith</u>* and C. R. Houska. Materials Engineering Dept., Va. Polytechnic Inst., Blacksburg, Va. 24060

Previous papers simplified the Warren-Averbach line-shape analysis by fitting a Fourier series with five parameters to a pair of x-ray diffraction peaks. Further modification of the line-shape analysis for thin films is presented here, which develops a Fourier integral with five separable Fourier coefficients. One can obtain particle size, uniform and nonuniform column strains from a pair of peaks. Also, two instrumental broadening coefficients per peak are used so that a very accurate representation of the instrumental broadening is obtained. A Gauss-Legendre quadrature is used to evaluate the theoretical function which is fitted to the experimental data by a least-squares analysis. A computer program written in FORTRAN IV performs the analysis. When used on the IBM 370 Computer System the computation time is reduced by a factor greater than 100 when compared to the previous Fourier series analysis. The anaysis has been performed on 1-μm thick Mo films on (111) Si single crystal substrates.

EFFECT OF ZINC CONTENT ON FLUORIDE INCORPORATION IN DENTAL AMALGAM. A. Y. Teng and L. B. Johnson. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901
   Five Ag-Sn alloys near the Ag$_3$Sn composition were chosen as basic materials to which to add zinc in increments of 1, 3, 5, and 7 atomic percent. The alloys were prepared by splat cooling and grounded to -400 mesh powders. These powders were treated with boiling HF for either 5 or 10 minutes, washed and dried at body temperature. They were then analyzed for fluoride content.
   The technique for fluoride analysis consisted basically of trapping the fluoride into solution by microdiffusion, followed by quantitative analysis using the fluoride ion-selective electrode.
   The amount of fluoride retained by the alloys appeared to depend on alloy composition, the HF treatment time and the extent of washing after the treatment. (Funded by USPHS grant DE 03965.)

Effect of Hydrogen Environments on the Age Hardening Characteristics of 2024 Al J. Wagner, M. R. Louthan, Jr., R. D. Sisson, Jr. and R. P. McNitt, College of Engineering, VPI, Blacksburg, VA.

   Aluminum samples were overaged at elevated temperatures in the presence of air and hydrogen — for times ranging from one to eight days. The results of tests done in air environments yielded a tight scatter band of decreasing hardness with increasing aging time. The air exposure data are easily reproduced. Tests conducted in a hydrogen environment produced hardness values with large scatter in comparison with the tests conducted in air. It is believed that scatter obtained in tests done in hydrogen was a result of varying levels of moisture content present in the test environment. The moisture reacts with the aluminum to form Al_2O_3 and hydrogen which is subsequently absorbed in the metal lattice. Hydrogen interacts with the θ phase changing the precipitation reaction and thus changing the aging characteristics of the alloy.

Hydrogen Effects on a Nitrogen Strengthened Steel R. C. Wasielewski, R. P. McNitt, R. D. Sisson, Jr., and M. R. Louthan, Jr., College of Engineering, VPI, Blacksburg, VA.

   Hydrogen effects on the notch tensile properties of nitrogen strengthen (21Cr, 6Ni, 9Mn) stainless steel were determined. High temperature thermal charging of hydrogen caused a reaction between the nitrogen in the steel and hydrogen resulting in the formation of ammonia gas. Thus the apparent hydrogen induced effects on the notch tensile properties of a 21-6-9 steel can result from actual hydrogen effects, nitrogen losses during hydrogen charging of internal ammonia formation. The latter two possible interactions are not considered in the interpretation of most of the hydrogen effects data presented in the current literature. Therefore many of the conclusions reached by previous investigators may be erroneous.

Medical Sciences

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ACUTE TOXICITY OF PHENYLCYCLOHEX-1-ENE IN RATS AND MICE,
B.A. Bagshaw*, V.M. Moser*, B.R. Martin, A.E. Munson and
L.S. Harris. Dept. of Pharmacology, Med. Col. of VA,
Richmond, VA 23298.

Phenycyclohex-1-ene (PC) is a pyrolysis product of phen-
cyclidine (PCP), a drug frequently abused by smoking. Our
objective was to determine whether or not PC contributed sig-
nificantly to PCP's toxicity and obtain baseline toxicity
data on PC. Charles River CD-1 mice (22-32 g) were injected
with either PC or PCP (prepared in 2.5% emulphor in saline)
and observed for 14 days. PCP was more toxic than

LD_{50} (C.L.) in Mice (μmoles/kg)

		I.V.	I.P.	P.O.
PCP	(Males)	57(53-61)	230(208-253)	284(244-330)
PCP	(Females)	76(68-84)	292(264-323)	342(287-408)
PC	(Males)	448(428-468)	1580(1280-1930)	>9500
PC	(Females)	425(415-435)	1570(1250-1980)	>9500

PC in both males and females, regardless of the route of ad-
ministration. Mice died immediately after i.v. administra-
tion of either PC or PCP, whereas mice died predominately
within 3 hrs. of PCP (i.p.) and 3 days of PC (i.p.). CD-1
rats (250-310 g) were injected i.v. with PC and the LD_{50}'s
for PC in males and females were 415(393-438) and 441(422-
472) μmoles/kg, respectively. It appears that the pyrolysis
product of PCP has less acute toxicity than PCP in both mice
and rats. Supported by grants DA-00490 and 1T32E507087

THE EMOTIONALLY DISTRUBED CHILD: AN ELECTROPHORETIC AND
PSYCHOLOGICAL CORRELATIVE STUDY. E.R. Berry, A.J. Finch* and
W. Draper*. Departments of Anatomy and Psychiatry, Medical
College of Virginia, Richmond, Virginia 23298

Serum samples by finger puncture were obtained from 15
patients at admission to the Virginia Treatment Center for
children. Six of the patients were followed for the duration
of their stay by samples at intervals of about 10 days for
this "double bind" study. Micro-agar gel electrophoresis
(Wieme) was utilized with Oil Red O as the lipo-protein stain
and Buffalo Black for protein. Mathematical analysis for the
composite tracings was by the interval method (Berry et al.).
Case history and evaluation of each child was made by the
Center staff. Correlation of withdrawal, hyperactivity and
prognosis with the electrophoretic status was by Stalling's
rho test.

The data of three patients followed in depth: one sub-
clinical hypothyroid, a sub-clinical hyper thyroid, and a
euthyroid child are presented. The T-3 binding pre-albumin
involved in surgical "stress" (Surks and Openheimer) with the
$\alpha_2 2$ "stress" pattern (Berry et al.) are illustrated. A three
dimensional plot of the admission data is discussed.

PROSTAGLANDIN D_2: ITS DEPRESSANT ACTION AND INVOLVEMENT
WITH SEROTONIN. Baxter, C.E.*,G.A.Patrick* and L.S.Harris
Dept. of Pharmacology, Med.Col. of Va.,Richmond, Va. 23298

Prostaglandin D_2 (PGD_2) has been shown to possess seda-
tive properties and to produce alterations in EEG recordings
when administered to cats, monkeys and rats. PGD_2 has been
shown to significantly potentiate pentobarbital sleeping
time in mice when administered in the lateral ventricle or
intravenously. Sleeping time was measured as the time be-
tween injection of PGD_2 and the mouse's regaining of the
righting reflex. Serotonin's role in PGD2 increase of pento-
barbital sleeping time was examined. Parachlorophenylalanine
a tyrosine hydroxylase inhibitor, significantly reduced by
55% PGD_2's potentiating effect. 5-Hydroxytryptophan, a
serotonin precursor, significantly enhanced the potentiating
effect of PDG_2 from 39.9±4.0 minutes to 51.3±7.2 minutes. A
toxin specific for serotonergic neurons, 5,7-dihydroxytrypt-
amine (5,7-DHT), decreased PGD_2's enhancement of pentobar-
bital sleeping time by 78%. Quipazine, a serotonin receptor
stimulant, also decreased the effect of PGD_2. The animals
with PGD_2 and pentobarbital slept for 41.5±2.4 minutes
while those with quipazine added in addition to the other
two slept for 32.3±4.5 minutes. These findings seem to im-
plicate serotonin in the role of PGD_2 as a possible endoge-
nous sedative agent, and suggest that the synthesis rate of
serotonin may be the important determinant in modulating
PGD_2's action. (Supported in part by grant #DA-00490.)

THE SOLUBLE EPITHELIAL PROTEINS IN THE GLAUCOMATOUS RABBIT
CORNEA. E.R. Berry, T.M. Harris*, L.B. Sheppard*. Depart-
ment of Anatomy, Medical College of Virginia, Richmond,
Virginia 23298.

Corneal epithelium, scraped from the eye, was frozen and
lyophilized.

Dry weight was determined, water added, 20 ul/mg, homogen-
ized, centrifuged to clear the supernate and a 2 ul sample
used for electrophoresis by the micro method of Wieme. Gly-
coprotein was determined by PAS staining. Protein, deter-
mined by Buffalo Black.

Normal epithelial tissue was from Ax/J and glaucomatous
tissue from AxBu/J Jackson lab rabbits.

Differences between the genetic lines are: soluble protein,
glycoprotein content and type, pre-albumin content and dis-
tribution, "albumin" content, and prodromal type.

Biochemical individuality, lack of bi-laberal symetry in
the eye pairs, and the lability of the glycoprotein are pre-
sented.

D-LACTATE FORMATION IN HUMAN BLOOD. R. B. Brandt. Dept. of Biochemistry, Med. Col. of Va., VCU, Richmond, VA 23298.

Methylglyoxal (MeG) has a potential role in control of cell growth. Metabolism of MeG to D-lactate (not the L-lactate of glycolysis) is catalyzed by the mammalian enzymes glyoxalase I (S-lactoyl-glutathione methylglyoxal lyase, isomerizing; EC 4.4.1.5) and glyoxalase II (S-2 hydroxyacyl glutathione hydrolase; EC 3.1.2.6), with glutathione as a coenzyme. Determination of MeG in tissues is difficult, due to the active glyoxalase system. However, the product, D-lactate, indicates formed or added MeG. A stereospecific assay was used for plasma D-lactate involving spectrophotometric analysis of NADH at 340 nm catalyzed by D-lactic dehydrogenase. Blood collected by venipuncture was used to determine plasma D-lactate concentration. The mean D-lactate plasma concentration for seven normal subjects was 0.023 mM 0.002 SEM. When the glycolytic pathway in whole blood was inhibited in vitro with fluoride, a significant increase in D-lactate was found (about 0.15 mM/hour at 37°). Added MeG gave a proportional increase in D-lactate concentration. Some specific precursors of L-lactate (dihydroxyacetonephosphate for example) added to whole blood increased the formation of D-lactate, even when glycolysis was not inhibited. This finding indicates that catabolites of glucose lead to MeG synthesis and suggests a control function for the glyoxalase enzyme system in glycolysis that may be exploited for cancer therapy. (This research was supported by funds from the National Foundation for Cancer Research.)

CHEMICAL CHARACTERIZATION OF NUCLEAR ENVELOPE PEPTIDES: A COMPARISON OF TRYPTIC PEPTIDE MAPS. D.L. Cochran and K.R. Shelton, Dept. of Biochemistry, Med. Col. of Va., Richmond, Virginia 23298

The insolubility of membrane proteins has plagued attempts to characterize this class of proteins by classical chemical methods. Nuclear envelope proteins have been no exception. By combining several recently developed methods we have obtained two-dimensional tryptic peptide maps of three nuclear envelope polypeptides. These predominant polypeptides in the avian erythrocyte nuclear envelope fraction have been isolated by a method combining isoelectric focusing in one dimension and sodium dodecyl sulfate polyacrylamide gel electrophoresis in the second dimension. Gel sections containing individual polypeptides were cut out and the polypeptides labeled with ^{125}I by the chloramine-T method, digested with trypsin overnight and spotted on cellulose thin layer plates. Chromatography was performed in the first dimension, the plates dried, and then electrophoresis performed in the second dimension. Fluorography was used to locate polypeptides on the plates. Of the three major polypeptides examined two share many spots while the third reveals a unique pattern. These results are consistent with the in vitro demonstration that two of the polypeptides are related by a cleavage process. (Work supported by grant #CA15923, NCI, DHEW).

EFFECTS OF PROTEIN INTAKE AND EXERCISE ON ABSORPTION SPECTRA SCANS OF BLOOD PLASMA FROM YOUNG MEN. G. Colmano, S. S. Edwards, N. L. Marable*. Col. Veterinary Med. and Dept. Human Nutr. & Foods*, VPI & SU, Blacksburg, VA 24061

Since Greek times, athletes   as part of their training, have consumed excessive amounts of meat protein in the belief that it would replace their spent muscle. In this context, the effects of a progressive resistance exercise program in young men fed the Recommended Daily Allowance of protein (RDA=0.8g/Kg body wt/day) or three times the RDA (2.4g/Kg body wt/day) were investigated. In order to study protein metabolism in humans, the current trend has been to rely on body composition, urinary nitrogen, creatinine, total serum protein, hematocrit, hemoglobin, and usual hematological indexes. These measurements were taken but did not necessarily reflect the protein turnover of the body in response to exercise. In animals, three major protein chromophore absorbances at 196nm, 278nm, 414nm, respectively for dipeptide bonds, aromatic amino acid residues, and hemoproteins, were detected spectrophotometrically and their concentrations were related to protein utilization. In the human subjects the absorbances of these chromophores were related to the metabolic protein status obtained by the accepted methods. The results from the normal and high protein intake groups under exercise indicated a lower urinary nitrogen relative to intake nitrogen. The spectrophotometric absorbances not only confirmed the results but also described changes in the concentration of the components of the three protein chromophores.

COMPARISON OF 260-280 nm ABSORPTION SPECTRA, LOWRY, AND BIURET DETERMINATIONS ON BSA STANDARDS AND BLOOD PLASMA. G. Colmano and S. S. Edwards. Div. Veterinary Biol., Col. Veterinary Medicine, VPI & SU, Blacksburg, VA 24061

Tryptophan, tyrosine, phenylalanine, histidine, and cystine have a common ultraviolet absorbance at 240nm, depending on amino acid components. As histidine and cystine have a low molar absorbance, the major contributions of tryptophan: tryosine:phenylalanine, at 27:8:1, have absorption maxima at 280nm, 275nm, and 258nm. The resultant absorption at 278nm, because of the constant concentration in proteins of the above amino acids, reflects the concentration of protein in blood plasma and serum, and is very close to 1 mg of protein/ ml for a spectrophotometric absorbance of 1 at 278nm. The ultraviolet 280nm absorbance has been used extensively for protein estimation in enzyme purification when the 260nm absorbance of nucleic acid was lower than the 280nm absorbance of the protein, which purity and concentration was then calculated on a 260/280nm nomograph, correcting for possible nucleic acid contamination. Because unfractionated blood plasma nucleic acid concentration does not contribute at 260 nm, the 280nm absorbance alone was used in dilutions (1:10, 1:200, 1:5000, which followed Lambert-Beer's Law for protein concentration, initially determined by the Lowry methods, which was not proportional to concentration, but had been described to be more accurate than the Biuret. Our Biuret and Lowry determinations confirmed previous findings, however, our linearity at 278nm for protein concentration in blood plasma has proven superior.

GLUCOCEREBROSIDES: THEIR PROPERTIES IN LIPID BILAYERS. M.C. Correa-Freire.* Dept. of Biochemistry, Univ. of Va., Charlottesville, VA 22908.

Glucocerebroside (Glc-Cer) is a simple glycosphingolipid and is found on the external surface of plasma membranes. In patients with Gaucher's Disease, Glc-Cer accumulates in reticulum endothelial cells and forms filament-like structures. We are interested in studying the properties and structure of Glc-Cer and its effect on the structure and properties of phospholipid bilayer systems. Small unilamellar sonicated vesicles and multilamellar liposomes were used as bilayer membranes systems. Glc-Cer can only be incorporated into these vesicles up to 20 mole %. Anthroyloxy and pyrene labelled Glc-Cer were synthesized and incorporated into bilayers to monitor phase transitions and phase separation in the phospholipid bilayer. The rate of exchange of Glc-Cer can be calculated by pyrene excimer formation and by ^{3}HGlc-Cer exchange between vesicles. The rate of Glc-Cer movement was slow. Calorimetric data suggests that above 10 mole % Glc-Cer forms patches in the phospholipid matrix. These results suggest that the behavior of Glc-Cer in vitro mimics its behavior in vivo. We postulate that as the Glc-Cer concentration in vivo is increased, the amount that the cell incorporates into its membrane is limited. Glc-Cer rich domains on the cell surface can be formed followed by a drastic precipitation of excess Glc-Cer into the cytoplasm producing the Gaucher Glc-Cer filaments. (Aided by NIH Grant GM 23573.)

Vascular Response to Acute Hypertensive Insult in the Cat. D.S. DeWitt, R.L. Hayes, J.T. Povlishock, D.P. Becker. Depts. of Neurosurgery & Anatomy, Medical College of Virginia, Richmond, Virginia 23298.

Acute hypertensive insult (HI) has been reported to cause the formation of lesions in feline cerebral vascular endothelium. This study was undertaken to investigate the temporal sequence of the genesis and resolution of such lesions. Cats were rendered hypertensive by the infusion of norepinephrine, and perfused 2, 10, 30 minutes and 4 and 8 hours after the onset of the HI. The brains were removed and samples were taken from cerebral cortex, diencephalon, brain stem and cerebral arterioles. The brain parenchymal samples were sectioned and, along with bisected pial arterioles, were processed for scanning electron microscopy. The luminal surfaces of the intraparenchymal vessels contained within the sections and the luminal surfaces of the pial arterioles were viewed and photographed with a scanning electron microscope. Lesions were counted from these micrographs. Endothelial balloons and craters appeared as early as 2 minutes after HI and were present in increasing numbers at 10 and 30 minutes. By the fourth hour after insult, the number of lesions had significantly decreased and by 8 hours, although there was no further significant decrease in the number of lesions, the lesions remaining appeared to be resolving as they were less conspicuous. These data suggest that acute HI initiates immediate endothelial damage which progresses and after several hours, begins to resolve. Supported by NIH Grant NS-12587.

The EPG, MASS PHOTORECEPTIVE POTENTIALS FROM A VERTE-
BRATE (frog: Rana esculenta). Clark S. Donley and
Hilmar Meissl*- The Collegiate Schools and The Max Planck
Institute, Richmond, Va. 23229 & Bad Nauheim, Germany

The pineal organ of the lower vertebrates is directly
photosensitive. In the frog an extracranial portion
(stirnorgan) provides wavelength ("color") information
while an intracranial portion (epiphysis) provides inten-
sity information to an as yet undetermined location for
an as yet undetermined function. The epiphysis produces
a potential (EPG) analogous to the ERG of the more usual
lateral eye. That the EPG reflects mainly massed recep-
tor activity is evidenced by the lack of a knee in the
dark adaptation curve, the dominance of the potential by
the scotopic component even under photopic light condi-
tions, the limited number of neural cells in the organ,
and some preliminary chemical studies.

The EPG consists of a rapid (less than 1 second) pho-
topic component responding best at longer wavelength, and
a slower scotopic response responding best at about 500 nm.
The EPG dark adapts about 3.5 log units over about an hour
and a half, light adapts again over about 30 minutes and
shows the remarkably long integration time of about 5 sec-
onds in the dark adapted state. The direct availability
of such photoreceptive potentials without the use of intra-
cellular recording or special chemical isolation suggests
the use of the preparation for such things as chemical
screening of receptor active drugs.

ESSENTIAL AREAS AND MECHANISMS OF MORPHINE ANTINOCICEPTION IN
RODENTS. T.C. FU, S.P. Halenda, W.L. Dewey. Dept. of Pharma-
cology, Med. Col. of Va., Richmond, Va. 23298

The essential areas for morphine antinociception and their
mechanisms were studied in the decerebrate and in the lightly
anesthetized mice and rats. The antinociception was quantita-
ted by the tail-flick response. Several techniques have been
used, including:(1) precollicular decerebration, (2) anemic
decerebration,(3) vertebral artery infusion, (4) cross-circu-
lation,(5) spinal ligation,(6) spinalization with dura mater
intact, and (7) spinal subarachnoid infusion. Morphine anti-
nociception was abolished or greatly reduced by percollicular
transection or by anemic decerebration in mice but not in rats.
Analgesia cannot be induced by a dose of 5mg/kg morphine di-
rectly perfused into forebrain region via common carotid
artery; however, it can be initiated by a much lower dose
(0.5mg/kg) of morphine infused via vertebral artery. Spinal
ligation abolished morphine induced antinociception in both
mice and rats. Spinalization with dura mater intact elimina-
ted the antinociceptive effect of morphine in rats but not in
mice. Tail-flick response can be effectively inhibited by sub-
arachnoid infusion of morphine at the level of T_{13} in mice and
rats. However, (D-Ala)^2-(des-COOH-Nle)^5-enkephalin is over
300 times (ED_{50}=0.015µg) more potent than morphine at the low-
er spinal level in mice, but in rats up to 150 times dose the
ED_{50} in mice produced no analgesia. From these findings it is
concluded that the areas and pathways involved in the mechani-
sm of morphine antinociception are different in the mouse from
the rat. (Aided by NIH grant DA01647)

CHEMOTAXIS OF AVIAN EMBRYONIC BLOOD CELLS BY ORGAN CULTURE
SUPERNATANTS. K.L. Holmes and J.L. Haar*, Dept. of Anatomy,
Med. Col. of Va., Richmond, Va. 23298

Blood borne hemopoietic stem cells (HSC), presumably
arising from the yolk sac (YS), are first seen in the
chicken bursa of Fabricius (BF) on the 10th day of gestation
followed by the appearance of increasing numbers of HSC's
between days 12 and 14. Several investigators have suggested
that a BF chemotactic factor may exist that selectively
attracts HSC's. This theory was tested using blind well
chemotactic chambers. The ability of embryonic (11-14d)
organ culture supernatants (SUP) of BF, liver and kidney to
attract YS cells of the same ages was compared with media
controls. YS cell suspensions were centrifuged on a BSA
gradient and cells banding between the 33% and 23% fractions
were removed for use in blind wells. YS cells were placed
in the upper chamber and separated from either supernatant
or control media below by a 5 µm Nuclepore polycarbonate
membrane. The liver SUP generally had higher than control
migration at all ages tested while the BF wells at 11 and
12 days failed to show even control level migration, but
increased to above control on days 13 and 14. The rise of
migratory activity between 12 and 13 days in the BF wells
corresponds to the influx of HSC's in the BF seen in vivo.
Migration of YS cells to the liver SUP's suggests the
possibility of a hemopoietic function in that organ,
contrary to recent reports. Electron microscopic observation
of 12d fetal liver indicates that it does contain HSC's.

IDENTIFICATION OF PHENYLCYCLOHEX-1-ENE, A PYROLYSIS PRODUCT
OF PHENCYCLIDINE IN SMOKE. A.S. FREEMAN*, B.R. MARTIN and
L.S. Harris. Dept. of Pharmacology, Med. Col. of Va.,
Richmond, Va. 23298

Parsley cigarettes (55 mm, 550 mg) were machine rolled
and injected uniformly, 10 mm from each end, with ethanolic
solutions of ^{3}H-phencyclidine (PCP). A simple smoking appar-
atus was designed to smoke the cigarettes and trap the smoke
on glass wool filters. The filters were washed with chloro-
form and the extract assayed for radioactivity. Of the ra-
dioactivity (0.5 µCi) injected into cigarettes containing
3, 10, 30, and 50 mg of PCP·HCl, 76±4, 84±2, 70±5, and 42±5%,
respectively, was recovered from the filters. In order to
quantitate ^{3}H-PCP and identify pyrolysis products, each
chloroform extract (150 µl) of the glass wool was applied to
two thin-layer plates as a band along with 10 µg of PCP and
phenylcyclohex-1-ene (PC). One plate was developed in chloro-
form (90 ml): methanol (10 ml): conc. ammonia (4 drops) in
which PC had an R_f of 1.0 and PCP had an R_f of 0.5. The other
plate was developed in hexanes (5 ml): conc. ammonia (1 drop)
in which PC had an R_f of 0.5 and PCP remained at the origin.
In both TLC systems, 48% of the recovered material was asso-
ciated with PCP and 48% with PC. Samples were also analysed
using GC-MS. A calibration curve was constructed using stan-
dard solutions of PCP and PC. Single-ion monitoring of their
respective base peaks showed that approximately equivalent
quantities of PCP and PC were present in the smoke conden-
sates. (Supported by NIDA Grant DA-00490)

PREFRONTAL PROJECTIONS TO THE CENTRAL GRAY IN THE MONKEY:
AN ORTHOGRADE AND RETROGRADE HRP STUDY. S.G.P. Hardy* and
G.R. Leichnetz*. Dept. of Anatomy, Med. Col. of Va.,
Richmond, Va. 23298.

The central gray (CG) is a structure to which many func-
tions have been attributed, including analgesia, aversion
and reward. In order to assess the potential influence
that the cortex may exert upon this structure a study was
made of the cortical efferents to CG in the monkey using
the horseradish peroxidase (HRP) technique. In a series of
cynomolgus (Macaca fascicularis) and capuchin (Cebus albi-
frons) monkeys, HRP gel placements were made in various
subregions of the prefrontal cortex, and stereotaxic HRP
fluid injections (0.01 µl 25% HRP in sterile saline) were
made into the CG. Gel placement cases were used to study
orthograde transport and fluid injection cases were studied
with regard to retrograde transport. After survival periods
of 24-48 hrs. the monkeys were processed according to the
tetramethylbenzidine protocol (Mesulam, 1978) and sections
were studied under bright and dark field microscopy. Results
from this study indicate that the prefrontal cortex projects
significantly to the CG, whereas few cortical areas outside
the frontal region are involved. The prefrontal-CG project-
ion arises primarily from small lamina V pyramids in the
medial prefrontal cortex and dorsal convexity. Other areas
of the prefrontal cortex also contributed projections of a
lesser extent to the CG, with the exception of the medial
orbital cortex.

BLOOD-BRAIN BARRIER DYSFUNCTION FOLLOWING CEREBRAL ISCHEMIA.
L. W. Jenkins*, J.T. Povlishock*, and D.P. Becker*, Depts. of
Neurosurgery and Anatomy, Med. Col. of Va., Richmond, Va.
23298

Sites of blood-brain barrier (BBB) dysfunction assessed by
increased permeability to horseradish peroxidase (HRP) were
correlated with neuronal alterations as evaluated by morpho-
logical analyses in adult cats subjected to complete cere-
bral ischemia (CCI). All animals were subjected to 5-8 min.
of CCI of which a limited number were perfusion fixed imme-
diately after the insult. The remaining animals were per-
fused after variable periods of post-ischemic recirculation
of up to an hour. HRP was injected either immediately pre-
ceding the insult or after periods of recirculation. Subse-
quent to perfusion fixation consistent brain segments from
all animals were subjected to vibratome sectioning and re-
acted for HRP visualization. In those animals perfused
immediately after CCI no increase in BBB permeability to HRP
was seen and a homogeneous population of neuronal altera-
tions was observed. However, in animals with recirculation,
focal HRP leakage was noted across numerous vascular seg-
ments. Concommitant with such leakage, the homogeneous
neuronal perturbations seen immediately following CCI were
modified into a heterogeneous pattern of more severe
neuronal alterations in sites displaying BBB dysfunction.
Such an observation suggests that BBB dysfunction may be
related to the maturation of neuronal injury seen during the
recirculation period following cerebral ischemia. (Aided
by NIH grant NS-12587)

CHANGES IN PITUITARY SENSITIVITY TO LH-RH AT PUBERTY: EVENTS OF THE INITIAL PROESTRUS. J.H. Johnson, Dept. of Anatomy, Medical College of Virginia, Richmond, Virginia 23298.

Pituitary responsiveness to pulse injections of LH-RH shows no dramatic change in prepubertal rats until the afternoon of the first proestrus. The present study was undertaken on the premise that use of a constant rate infusion of LH-RH might reveal responses not observed in previous studies. Groups of rats were studied between the ages of 36 and 43 days. Phenobarbital was injected at noon to eliminate endogenous LH-RH release. Beginning at 14:00, blood samples were obtained at half hour intervals during the 3-hour period when LH-RH was infused at 50 ng/hr through a double-lumen jugular cannula implanted 1-4 days earlier. Vaginal opening occurred at proestrus or estrus on days 41-43. The peak level of circulating LH was significantly greater at age 42 than at 36, 38, 40 or 43. Responses at other ages were not statistically different from one another. However, the peak LH response was most significantly correlated with the stage of the estrous cycle: that observed at proestrus was greater than those of diestrous, estrous or anestrous (prepubertal) animals. These results fail to suggest an essential role of altered pituitary responsiveness in the onset of puberty. Rather, in agreement with the results of previous investigators, they reflect events at the initial proestrus, indicating that cyclic mechanisms have already been set in motion. (Supported by NIH Grant HD 11247)

EFFECT OF HALOPERIDOL ON SPONTANEOUS LUTEINIZING HORMONE RELEASE AND SUBSEQUENT OVULATION IN THE RAT. Richard J. Krieg Jr., and James H. Johnson, Department of Anatomy, Med. Col. of Va.-Va. Com. Univ., Richmond, VA. 23298.

The capability of haloperidol (H) to block dopaminergic inhibition of prolactin (PRL) release at the pituitary level is well established. The present studies were designed to investigate the effect of H on luteinizing hormone (LH) release and ovulation in normally cycling proestrous rats. Doses of 0.125, 0.25, 0.5, and 1.0mg/kg of H were administered sc. in corn oil at 1330 h. Blood samples were taken via intra-atrial catheter immediately prior to injection, and at two hour intervals from 1430 to 2230 h. Animals were checked for ovulation on the next morning. A significant release of PRL occurred within one hour after injection of all doses of H except 0.125mg/kg. The proestrous surge of LH was not blocked by any of the doses of H and ovulation was observed in 5/8(1.0mg/kg), 4/7(0.5mg/kg), 4/7(0.25mg/kg), and 5/5(1.0 mg/kg) animals. These data show that afternoon administration of H does not block LH release or ovulation at the doses presently used. This stands in contrast to other studies in which similar doses of H were shown to block ovulation if injected at 0930 h (Neuroendocrinology 15: 10-20, 1974). Further experiments are in progress to explain whether this difference is due to a direct effect of H, or a secondary effect (such as PRL release) which blocks ovulation only if it occurs well in advance of the LH surge. (Supported by NSF grant #PCM7922155, and NIH grants HD11247 and HD12169).

DYNAMICS OF CYTOCHROME b_5 -MEMBRANE INTERACTIONS. T.L. Leto.* Dept. of Biochemistry, Univ. of Va. Sch. of Med. Charlottesville, Va. 22908.

Cytochrome b_5 (cyt b_5) is an integral membrane protein found in high concentrations on the endoplasmic reticulum in liver and is involved in unsaturated fatty acid biosynthesis. Cyt b_5 is the first integral membrane protein to demonstrate exchangeability between membrane structures in vitro. Fluorescence methods have been used to study the binding of cyt b_5 to membranes, intermembranous exchange of cyt b_5, and the topology of cyt b_5-membrane complexes. Enhancement of cyt b_5 tryptophan fluorescence occurs upon association of this protein with a variety of membrane preparations. The binding of cyt b_5 to membrane preparations derived from brominated phospholipids results in a quenching of cyt b_5 fluorescence. These observations indicate that binding involves an association of cyt b_5 with the hydrophobic core of the membrane. The kinetics of cyt b_5 intermembranous exchange between the quenching and enhancing membranes has been followed directly from the observed protein fluorescence. Suitable controls have ruled out the possible occurrence of significant exchange of lipids or fusion of membranes to account for the fluorescence changes. Based on these kinetic studies we propose that exchange of cyt b_5 is due to the existence of a free aqueous form of cyt b_5 which is in equilibrium with the membrane bound species. (Supported by NIH grants GM 23258 & 5T32 CA 09109)

MESOIONIC HETEROCYCLES AS INHIBITORS OF C-AMP PHOSPHODI-ESTERASE. Julie Maconaughey, Drs. JD Smith, RA Glennon*, ME Rogers*; Dept. of Pharm. Chem., MCV-VCU, Richmond,23298.

Phosphodiesterases (PDE) are a group of enzymes which regulate intracellular levels of cyclic nucleotides. For example, cyclic AMP PDE catalyzes the hydrolysis of c-AMP. Theophylline, a 1,3-dimethylxanthine, is a known competitive inhibitor of PDE. Structural modifications of the xanthine have led to more potent and selective inhibitors. A previously synthesized series of mesoionic xanthine analogs revealed theophylline-like activity as PDE inhibitors. In order to further investigate structure/activity relationships and in an attempt to optimize activity, it was of interest to synthesize analogs with various substituents on the original mesoionic purine analog. We also prepared examples of several ring systems where the 5-membered ring has been replaced by a pyridine, pyrimidine, or isoquinoline moiety. The target compounds were synthesized via a thermal condensation of a bis(2,4,6-trichlorophenyl) malonate ester with the appropriately substituted alkyl-aminoheterocycle. The latter was prepared either through an acylation-reduction or by a Dimroth rearrangement. The compounds were tested for PDE inhibition using the Klee Assay, and the results will be more fully discussed in the following paper. Briefly, as inhibitors of cyclic AMP PDE, the activities of the mesoionic compounds (I_{50} values) ranged from 50-2000μm, compared to 300μm for Theophylline.

THE RESPONSE OF THE RETRACTOR BULBI MUSCLES TO OCULOMOTOR NERVE STIMULATION IN THE CAT M.A.Meredith* and S.J. Goldberg*, Dept.of Anat., Med.Col.Va., Richmond, Va. 23298

Recent studies have suggested that a small population of retractor bulbi (RB) motoneurons (MM) are located within the oculomotor (OC) nucleus. The present experiments were conducted to establish the presence of RB axons within the OC nerve and to determine their distribution to the RB muscle. In the orbit, the RB muscles were cut from their insertions and attached to tension transducers. A bipolar steel electrode was used to stimulate the OC nerve in the brainstem. OC nerve branches to the superior rectus, medial rectus, inferior rectus, and inferior oblique muscles were cut and the contralateral abducens (AB) nerve and nucleus were lesioned. Contractions of the RB muscles produced by OC nerve stimulation were characterized by faster contraction times, faster half-decay times, and weaker whole muscle tensions than reported for responses elicited by AB nerve stimulation. The response of the RB muscles varied between individual cats and an estimated 0-15 RBMMs project to motor units in each muscle slip.

These results confirm the presence of RB axons in the OC nerve, possibly distinguish those RB motor units from units controlled by the AB nerve, and suggest a role of the RB muscles in patterned eye movements.
(Aided by USPHS grant EY-01442)

HEMODYNAMICS, HYPOGLYCEMIA AND HEPATO-PANCREATIC PATHOLOGY DURING THE COURSE OF ENDOTOXIN SHOCK. N.H. Manson*, T.H. Wendel*, L.R. Eaton*, and M.L. Hess. Depts. of Physiology and Medicine. Med. Col. of Va., Richmond, Va. 23298

The interrelationship between hemodynamics and hypoglycemia during the course of Endotoxin Shock (ES) has not been fully defined. In the following study, ES (E. coli, 1 mg/kg; n=7) was induced in a canine model and systemic hemodynamics, glucose metabolism, and hepatic and pancreatic function monitored for 5 hrs. and compared to Time Matched Controls (TMC,n=4) Total Peripheral Resistance (TPR, dynes-sec-cm^{-5}) increased from 3227 ± 430 to 4050 ± 750 at 30 min and then declined to 3050 ± 1100. At 90 min, TPR progressively increased to 6225 ± 749 by 5 hrs. Plasma glucose did not significantly differ from control values (105 ± 4 mg%) for the first 90 min but then declined to 78 ± 2 mg% at 5 hrs. (TMC = 98 ± 4, p<0.05). Serum amylase during the 5 hr. protocol was not elevated (TMC = 110.9 ± 2.4; ES = 100 ± 1.97% p<0.01) and light microscopy of the exocrine pancreas demonstrated normal acinar structure. In contrast, islet cell structure from the ES group demonstrated clumping and disruption not seen in the TMC. Hepatic histology in the ES group demonstrated periportal and perilobular degranulation and hepatocyte disruption not seen in the TMC. It is hypothesized that ES results in a circle of positive feedback initiated by an increase in TPR and subsequent decrease in flow resulting in hepatopancreatic ischemia with preferential islet cell disruption producing, in part, the hypoglycemia of ES. (Aided by NIH grant HL 24502-01)

PHOSPHOLIPID DISTRIBUTIONS IN LARGE UNILAMELLAR VESICLES.
J.R. Nordlund*. Dept. of Biochemistry, Univ. of Virginia
School of Medicine, Charlottesville, Virginia 22908.
    Membranes regulate cellular activities by compartmental-
izing cellular functions. Compelling evidence exists which
supports the notion that membrane constituents are asym-
metrically distributed. The tendency of phospholipids to
form asymmetric bilayers has been examined in unilamellar
vesicles of various diameters. The distribution of egg
phosphatidylethanolamine(PE) in large unilamellar egg
phosphatidylcholine(PC)-egg (PE) vesicles was determined by
2,4,6-trinitrobenzenesulfonic acid labeling. These vesicles
were obtained by modifying the ethanol injection procedure
described by Batzri and Korn, using a slow injection rate.
After injection the ethanol was removed and the vesicles
were centrifuged. This resulted in a homogeneous, large
and unilamellar vesicle population as determined by column
chromatography and ^{31}P NMR. PE in vesicles of 10, 30, and
50 mole percent PE was found to be equally distributed
between the two monolayers. In contrast, PE in PE-PC small
unilamellar vesicles formed by rapid ethanol injection was
preferentially localized in the outer monolayer at low PE
concentrations and in the inner monolayer at high PE con-
centrations. These results suggest that while phospholipids
may spontaneously form asymmetric bilayers in highly curved
regions of biological membranes, other factors must be re-
sponsible for phospholipid asymmetry in general. (Aided by
USPHS, NIH grants GM-14628 and GM-23573.)

HISTOLOGICAL CHANGES IN RAT HEARTS AFTER SINGLE EPISODES OF
FORCED EXERCISE. *S. Rapundalo*, Dept. of Physiol., Med. Col.
of Va., Richmond, Va. 23298; M. Persinger* and M. Alikhan*,
Laurentian Univ., Sudbury, Ontario, Canada.*
    Groups of young and old rats were exposed to a single episode of
either forced running: 1, 6, 12 or 24 hr duration, or to sedentary con-
ditions for similar durations. Both young and old rats demonstrated
highly significant increases in cardiac weight (F(3,46)=16.01, p<.01)
and body weight loss (F(3,46)=9.83, p<.001) as a function of exercise
duration. Animals subjected to the same treatments but allowed to
recuperate for 24 hr showed some reversal of these effects. Chi-
square analysis of the 4 run times with the two age groups and histo-
logical ratings indicated a significant effect (X(12)=35.7, p<.001)
for the basal level of the heart. No significant differences for other
areas of the heart or between ages were evident. Histological data,
as compared to controls, indicate the following: (1) the majority of
fuchsinophilia and necrosis occurred within the base of the left ven-
tricle, especially within the subendocardium; (2) the degree of "wav-
iness" within muscle bundles and of the width of interfiber space in-
creased with exercise duration. These studies indicate that acute
maintained exercise can produce histological changes indicative of
myocardial degeneration and necrosis, as well as cardiac edema.
This rapid process of cardiac edema appears to be somewhat reversible
if the stressor is removed and the animals allowed to recuperate for a
period of 24 hr, although histological changes remain.

BRAIN REGION AND SUBCELLULAR DISTRIBUTION OF RADIOACTIVITY
IN MICE AFTER ACUTE ADMINISTRATION OF ^{14}C-POLYCHLORINATED
BIPHENYLS. D.L. Rosin,* B.R. Martin and G.A. Patrick.*
Dept. of Pharmacology, Med. Col. of Va., Richmond, VA.
23298
    Previous studies in our lab have shown that polychlorina-
ted biphenyls (PCBs) alter central neurotransmitter function
in vitro at concentrations of 10^{-5} to 10^{-4} M and depress
spontaneous motor activity of mice after an oral dose of 500
mg/kg. Radiolabelled PCBs were added to in vitro systems
and administered orally to determine tissue levels and dis-
tribution in brain. Mice were administered an oral dose of
PCBs of 500 mg/kg containing 2-4 μCi ^{14}C-PCBs and were de-
capitated at various times. Brain, liver and plasma levels
of radioactivity were measured at 0.25, 0.5, 0.75, 1, 2, 4,
and 8 hrs after gavage. Levels increased up to 2 hrs then
reached a plateau. The 0.75 and 2 hr time points were cho-
sen for studying distribution in brain areas and subcellular
fractions of whole brain. Radioactivity was distributed ev-
enly in 6 brain areas at both time points with levels about
3 times higher at 2 hrs than at 0.75 hr. In subcellular
fractionation of brains, the largest proportion of radioac-
tivity was distributed to myelin, synaptosomal, and micro-
somal fractions. Levels observed in these fractions follow-
ing oral administration were comparable to those which al-
tered central neurotransmitter function in vitro.
(Supported in part by EPA Grant R-806481 and NIH Training
Grant GM-07111)

STUDIES ON HOST VERSUS GRAFT SYNDROME. C.H. O'Neal, Sue S.
Cross,* J. J. Ruffolo,* and R. Hard.* Depts. of Biophysics
and Pathology Med. Col. of Va., Richmond, Va. 23298
    Experimental Host Versus Graft Syndrome (HVG) is a
fatal complex of lesions which may follow the perinatal
inoculation of $(T_6 \times RFM)F_1$ hybrid spleen cells into
a related RFM strain mouse. HVG mice usually die in 30
days of membraneous glomerulonephropathy from deposition
of immune complexes. Other pathologic changes include
T(-) immunodeficiency, hyperimmunoglobulinemia, liver
and renal lesions, plasmacytosis and under some conditions,
tumors of the lymphatic system and liver. IgG_1 levels
of the HVG mice may be elevated 30-70 times control values.
IgA and IgM appeared early in the syndrome followed by
rapid increases in all serum Ig levels. IgG_1 and IgG_2
declined in the last stage of the disease and IgM levels
were above the adult maximum. Murine leukemia virus
has been isolated from both parental types, the F_1 and
the HVG animal. The F_1 virus has been shown to be a
typical ecotropic MuLV by morphological, immunological
and physical criteria. A mouse tropic virus has been
isolated from the HVG animal. In a preliminary study
on a tumor from the liver of a C_3H mouse,virus can be
easily seen. Characterization of the various viral
isolates is underway. Serum protein patterns of the two
parental strains, the F_1 animal and the HVG animal exhibit
qualitative differences. (Supported by ACS Grant IM-125)

DIFFERENTIATION OF PRE-B CELLS IS INDUCED BY HY-
BRIDIZATION WITH MYELOMA CELLS. S. C. Riley*,E.
J. Brock*, and W. M. Kuehl*. Dept. of Microbiol-
ogy, Univ. of Va., Charlottesville, Va. 22908
    Murine pre-B cells, which express cytoplasmic
μ heavy chain but no L chain, are the progenitor
cells of surface Ig^+ B lymphocytes. An Abelson
murine leukemia virus transformed lymphoid mouse
cell line (18-81) has pre-B cell characteristics.
18-81 was fused with myeloma cell lines in an at-
tempt to induce the next step in pre-B cell dif-
ferentiation, i.e. L chain expression. 40% of
somatic hybrids between 18-81 $(\mu c^+, L^-)$and a var-
iant myeloma cell $(\gamma 2a^+, L^-)$ express a κ L chain
which is not produced by either of the parents.
The κ L chain expressed in the pre-B cell x mye-
loma hybrids is coded for by the pre-B cell gen-
ome. The L chains expressed by independent 18-81
x myeloma hybrids are also shown to be different
by peptide mapping. (Aided by NIH Grant AI 12505-
05).

RESPONSIVENESS OF THE RAT AORTA AND FEMORAL ARTERY TO EPI-
NEPHRINE AND HISTAMINE DURING PREGNANCY. R. F. Sisson, III*
and J. L. Hart. Dept. of Biology, George Mason Univ.,
Fairfax, Va. 22030
    The responsiveness of isolated arteries to epinephrine
(E) and histamine (H) before and at two times during preg-
nancy (8-12 days and 18-22 days) were compared. Helically
cut aortic strips (A) (6-10mm x 2mm) and femoral artery cyl-
inders (FA) (4-6mm long) from 2-3 month old SD rats were
suspended in 30ml oxygenated Krebs-filled baths at 37°C.
Isometric tension was recorded while cumulative dose-
response curves to both E and H were done on each tissue.
Mean (+SE) maximum tension (mg tension/mg tissue weight)
(contractility) is listed in the Table (N=6-7 at each time).
Although contractility was greater, especially during mid-
pregnancy, for both arter-
ies in response to both E
and H, ANOVA indicated
that none of these changes
was significant (p > .05).
These results do not sup-
port previous studies that
have reported decreases in
responsiveness of blood
vessels to some vasoactive
agents during pregnancy.
(Supported by GMU Grant
#5-25012 and NSF Grant DEB 79-05841.)

MAXIMUM TENSION			
	Non-preg	8-12 day pregnant	18-22 day pregnant
Epinephrine			
A	205+36	301+11	259+27
FA	300+62	409+45	316+65
Histamine			
A	124+13	220+33	176+24
FA	92+14	155+25	116+24

COMPOSITIONAL DOMAIN STRUCTURE IN PHOSPHATIDYLCHOLINE-CHOLESTEROL AND SPHINGOMYELIN-CHOLESTEROL MIXTURES. **B. Snyder***, Dept. of Biochemistry, University of Virginia, Charlottesville, Va. 22908

The lateral organization of cholesterol in phospholipid bilayers has been investigated through a method of Monte Carlo calculations using interaction energies deduced from calorimetric results for cholesterol-phospholipid mixtures. Analysis of computer generated bilayer configurations allows calculation of the spatial localization and relative abundance of distinct regions of varying cholesterol content along the plane of the bilayer. The results indicate that the degree of nonideality in the mixing of cholesterol is dependent on the fatty acid chain lengths of the phospholipid and that cholesterol mixes more ideally in sphingomyelins that in phosphatidylcholines of equal chain length. It is found that at ≈ 20 mole % cholesterol those membrane regions which are rich in cholesterol suddenly become connected forming a network which extends over the entire bilayer. This change in the lateral connectivity of the cholesterol rich domains occurs over a very narrow concentration range and is accompanied by a parallel decrease in the connectivity of the free lipid domains. This long range connectedness transition is presumably responsible for the abrupt change in the lateral diffusion coefficient and the sharp decrease in the ability for protein incorporation observed at this concentration. (Supported by NIH grants GM-27244 and GM-26894).

MODULATION OF IMMUNOCOMPETENCE IN MICE DURING DMH-INDUCED COLORECTAL CARCINOGENESIS. **A.K.** Szakal, B.A. Diwan*, and K.E. Blackman*, Dept. of Anatomy, Med. Coll. Va., Richmond, Va. 23298 and Life Sciences Div.*, Meloy Labs, Inc. Springfield, Va. 22151.

A tri-phasic modulation of immunocompetence was demonstrated in 1,2-dimethylhydrazine (DMH) treated SWR/J mice in a correlative study utilizing mitogenic stimulation of T and B lymphocytes, histological parameters of lymphoid tissue immune responses, and colorectal tumor development.

In phase I, a depression of the regional and an enhancement of the systemic immunocompetence initiated by DMH preceded the development of the initial colorectal lesions. In phase II, an enhanced regional and systemic immunity, as well as an extensive splenic myeloid metaplasia corresponded to morphogenetic changes in the colorectal epithelium representing a transition from hyperplasia to neoplasia. In phase III, a reduction in both regional and systemic immunocompetence was associated with the growth of adenocarcinomas. Systemic immunity, as indicated by the continued depression of mitogen reactivity and the depletion of the splenic white pulp was abrogated concomitantly with the increase in tumor burden. Regional immunity, however, recovered and became enhanced simultaneously with the appearance of invasive adenocarcinomas.

The observed modulation represents a dynamic tumor-host interaction favoring colorectal tumor development.

EVALUATION OF A SERIES OF MESOIONIC XANTHINE ANALOGS AS PHOSPHODIESTERASE INHIBITORS. Sheree L. Thomas*, Michael E. Rogers*, Richard A. Glennon*, J. Doyle Smith. Dept. of Pharm. Chem., Med. Col. of Va., Richmond, Va. 23298

Methylated xanthines, such as theophylline inhibit cyclic nucleotide phosphodiesterases, an effect that may be responsible for their clinical utility. Because of the close structural similarity, mesoionic xanthine analogs are capable of inhibiting phosphodiesterase. The purpose of this research was to evaluate a series of mesoionic xanthine analogs for their ability to inhibit bovine heart cyclic AMP phosphodiesterase. A radiolabeled assay was used as previously described. In brief, tritiated cyclic AMP was incubated with bovine heart phosphodiesterase in the presence and absence of inhibitors. The product, 5'-AMP, was isolated via chromatography using an ion exchange resin and was quantitated using liquid scintillation counting. I_{50} values were determined by plotting uninhibited velocity/inhibited velocity (Vo/V) versus the inhibitor concentration. The I_{50} is the inhibitor concentration when Vo/V = 2. Five different inhibitor concentrations, giving 25-75% inhibition, were used for each inhibitor. Fifteen new mesoionic compounds were examined including three new ring systems. Structure activity relationships for these compounds indicate that variation of groups on the ring system significantly influences inhibitor activity, the mesoionic six-membered ring is necessary for good activity, and variation of the non-mesoionic five-membered ring can lead to compounds with enhanced activities as inhibitors.

DESIGN AND SYNTHESIS OF IRREVERSIBLE PHOSPHODIESTERASE INHIBITORS. K.A. Walker and M.E. Rogers, Dept. of Pharmaceutical Chemistry, Med. Col. of Va., Richmond, Va. 23298

Cyclic adenosine monophosphate (cAMP) has been shown to to regulate or influence a wide range of physiological functions. Intracellular levels of cAMP are regulated primarily by the cyclases which catlyze its synthesis and by phosphodiesterase (PDE) which catlyzes its degradation. PDE is not a simple molecular entity, but a complex enzyme system existing in multiple molecular forms. Differing molecular forms of PDE are unique to each tissue and even to each cell type. Selective inhibition of different PDE isozymes would make it possible to raise cAMP levels in discrete cell types, thereby manipulating specific biological processes.

By preparing an inhibitor with maximum affinity for an enzyme and incorporating an alkylating function capable of forming a covalent bond, an active-site directed irreversible inhibitor is achieved and a further degree of selectivity is available. Although papaverine is one of the most potent known PDE inhibitors it is also one of the least specific. Modifications on the papaverine molecule involving introduction of an alkylating moiety could enhance its specificity and result in irreversible inhibition of PDE. A series of 6,7-dimethoxy-1-phenylisoquinolines have been synthesized to investigate the irreversible inhibition of PDE.

EFFECTS OF ANTINOCICEPTIVE DOSES OF OXOTREMORINE ON CHOLINERGIC SYSTEMS OF THE MOUSE BRAIN. H.L.Tripathi*,F.J. Vocci* and W.L.Dewey, Department of Pharmacology, Med.Col. of Va., Richmond, Va. 23298

We have studied the effects of antinociceptive doses of oxotremorine on the levels of acetylcholine (ACh) choline (Ch) and turnover rate of ACh in whole mouse brain following two methods of sacrifice, decapitation and microwave irradiation. Antinociceptive activity in mice was determined by the tail-flick method (6 mice/gp) and effective doses ED_{16} (9μg/kg) ED_{50} (13μg/kg), and ED_{84} (20μg/kg) were determined by the method of Litchfield and Wilcoxon. These doses were administered subcutaneously and ACh levels were determined at 15,30,45 and 60 min. intervals. The ED_{84} dose showed a significant increase in ACh levels at 15 and 30 min.intervals by both methods. The turnover rate of ACh and Ch levels were determined 20 min. after drug administration. A dose dependent decrease was found in turnover rate of ACh. The ACh turnover rate decreased from 11.06±1.62 n mol/g/min. to 5.38±0.71 n mol/g/min. by the decapitation method and 30.20 ±1.8 n mol/g/min. to 19.99±1.6 n mol/g/min.by the microwave irradiation method. A significant increase in Ch level was found by the ED_{84} dose of oxotremorine by microwave irradiation method but not by the decapitation method. Significantly lower values of ACh, Ch and ACh turnover rate were found in decapitated animals as compared to microwave irradiated mice. (Supported by USPHS DA-00326, DA-07027 and DA-00490).

THE GLYOXALASE SYSTEM IN THE GROWING RAT. M. G. Waters*, R. B. Brandt, D. J. Muron*, M. H. Bloch*. Dept. of Biochemistry, Med. Col. of Va., VCU, Richmond, VA 23298

The 3-carbon keto-aldehyde, methylglyoxal (MeG), has been shown to inhibit growth in bacterial and mammalian systems. The glyoxalase enzyme system catalyzes the cytotoxic α,β-dicarbonyl to form D-lactate in the presence of glutathione (GSH). Glyoxalase I (S-lactoyl-glutathione methylglyoxal lyase, isomerizing; EC 4.4.1.5) and glyoxalase II (S-2 hydroxyacyl glutathione hydrolase; EC 3.1.2.6) are ubiquitous in mammalian tissues and have a high specific activity in red blood cells. In order to determine possible changes in the glyoxalase system with growth, the various components of the glyoxalase system were measured in the blood of male Sprague-Dawley rats aged 20 to 135 days. Glyoxalase I and II activity and kinetic parameters were determined in phosphate buffer. Glutathione reductase activity, blood concentration of GSH and protein, plasma concentration of D-lactate, and hematocrit were also measured. The glyoxalase II catalysis of S-lactoyl-glutathione (SLG) to D-lactate is the rate determining step in the catabolism of MeG in blood. The V_{max} for the reaction was 42 μmoles/min/ml blood compared to 82 μmoles/min/ml RBC for glyoxalase I. The K_m values for MeG and SLG were 0.9 mM and 1.2 mM respectively. The K_m and V_{max} for the glyoxalase reactions were found not to be age dependent in the first 4 months of life. (This research was supported by funds from the National Foundation for Cancer Research.)

STREPTOZOTOCIN(STZ) INDUCED CHANGES IN RAT LIVER TRIGLYCERIDE (TG) CONTENT AND GLYCEROLIPID BIOSYNTHESIS. Judith A. Woods* and Robert G. Lamb. Departments of Pharmacology and Medicine, Medical College of Virginia, Richmond, Virginia 23298.

Diabetes (STZ-induced) rapidly increases rat serum and liver TG content and hepatic TG synthesis. These diabetic dependent changes in the level and formation of TG are related to alterations in insulin levels since they are reversed by insulin administration.

The STZ-dependent rise in hepatic TG formation is partially explained by an increase in the activity of enzymes(phosphatidate phosphohydrolase and GP acytransferase) regulating the incorporation of sn-$[1,3-^{14}C]$glycerol-3-P(GP) into TG. Diabetes induced increases in liver TG biosynthesis and enzyme activity are associated with alterations in serum factors since hepatocytes and hepatocyte monolayers exhibit an increased capacity to incorporate GP into TG following exposure (1-18 hr) to serum isolated from diabetic animals compared to control serum. The importance of serum factors was also supported by the observation that hepatocyte monolayers exposed to a mixture of control serum and serum components (glucagon, oleate, glucose and ketones) elevated by diabetes, exhibited increases in TG formation which were identical to those produced by diabetic serum. Hepatocytes exposed to individual agents (ketones>oleate>glucagon>glucose) also showed a rise in TG biosynthesis; however, a mixture of agents always initiated a greater response. (Supported by NIH grants AM 18976 and 21924).

THE RELATIONSHIP BETWEEN SURFACE AND SECRETED IgG2A IN MOUSE LYMPHOMAS. C. J. Word* and W. M. Kuehl*. Dept. of Microbiology, Univ. of Va. Sch. of Med., Charlottesville, Va. 22908

A spontaneous Balb/c murine B-lymphoma, A20, expresses immunoglobulin (Ig), Fc receptors and Ia antigens on its cell surface, but no complement receptors, thus representing an intermediate in the differentiation scheme of B-cells. Biosynthetic cell labeling reveals that A20 synthesizes two species of intracellular γ_{2a} heavy (H) chains with molecular weights of 62,000 and 68,000 daltons, each of which is associated with κ light chains. Secreted IgG$_{2a}$ contains γ_{2a} H chains of 64,000 daltons while surface IgG$_{2a}$ contains 70,000 dalton γ_{2a} H chains. Fusion of A20 to a terminally differentiated murine myeloma results in a hybrid expressing a more differentiated phenotype for the A20 IgG$_{2a}$. Synthesis of the secreted form of the lymphoma IgG$_{2a}$ is amplified 10-100 fold but the surface form of the lymphoma IgG$_{2a}$ is no longer expressed in the hybrid. The data suggest that the 62,000 dalton intracellular γ_{2a} H chain is the precursor to the secreted IgG$_{2a}$, while the 68,000 dalton intracellular γ_{2a} H chain is the precursor to the surface IgG$_{2a}$. Peptide map analysis indicates that the two intracellular γ_{2a} H chains have identical methionine-containing peptides and may be coded for by the same γ_{2a} H chain gene. (Supported by NIH Grant AI 12525-05).

Microbiology

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

UTILIZATON OF PEPTIDES BY NEUROSPORA CRASSA AS A SOLE SOURCE OF NITROGEN. J. Castellano and L. Wolfinbarger, Jr., Department of Biological Sciences, Old Dominion University, Norfolk, Va. 23508
    Peptides ranging in size from a mean number of residues of 30 down to dipeptides support growth of a leucine auxotroph when used as both a nitrogen and leucine source. Under nitrogen limiting conditions the peptides "induce" extracellular peptidohydrolytic activity which hydrolyzes the peptides to monomer amino acids. Growth of leu-2 on those peptides transportable by the oligopeptide transport system does not result in "induction" of hydrolytic activity whereas growth of leu-2; glt-r, which lacks a transport system, results in induction of peptidohydrolytic activity on these same peptides.

A POTENTIAL MACROREGULATORY MECHANISM FOR GROWTH REGULATION IN NEUROSPORA CRASSA. M. Mooney*and L. Wolfinbarger, Jr. Department of Biological Sciences, Old Dominion University, Norfolk, VA 23508
    Neurospora produces a phase specific cationic mucopolysaccharide, composed primarily of galactosamine (GAG-MP), which becomes part of the cell wall and is later secreted into the media. Its appearance coincides with the onset of the restricted phase of growth, following cessation of small molecular weight metabolites when incubated with conidial cells. This activity may be a product of electrostatic interactions of the GAG-MP with the conidial plasma membrane. The activity is blocked by acetylation of the primary amines on the molecule, digestion by enzymes that hydrolyze carbohydrate linkages and the inclusion of NaCl (1M) in the GAG-MP/conidia reaction mixture. The GAG-MP's physiological activity mimics that of known depolarizing agents. A model is proposed in which GAG-MP depolarizes the plasma membrane at the onset of the restricted phase of growth, stimulating a cell surface enzyme to produce endogenous cAMP which in turn switches on the enzymatic and genetic machinery necessary for that phase of growth. (Aided by Grant from National Foundation March of Dimes)

INACTIVATION OF POLIOVIRUS-2 IN NATURAL WATERS: A THERMO-LABILE FACTOR. J.C. Johnson, R.P. Olson*, and P.G. Haggerty*, Dept. of Biological Sciences, ODU, Norfolk, VA. 23508.
    The inactivation of a plaque-purified poliovirus-2 in natural fresh and marine surface waters obtained from Southeastern Virginia was found to be biphasic with the initial inactivation rate at $17^\circ C$ six to ten-fold greater than the secondary rate. Most (70 to 90%) of the inactivation occurred during the initial rapid phase and was found by sedimentation studies to be related to the amount of virus aggregates. Using an assay for proteolysis which measured the mobility and dispursity of polypeptides by means of polyacrylamide gel electrophoresis in the presence of sodium dodecyl sulfate, ^{125}I labelled bovine serum albumin was found to be nearly 50% hydrolyzed after 25 days of incubation in filter sterilized marine surface water at $17^\circ C$. Similarly, ^{14}C-amino acid labelled poliovirus-2 polypeptides VP1, VP2, VP3, and VP4 were found to be extensively degraded in filter sterilized ocean water but not in autoclaved and filter sterilized, deionized or marine water, although in the latter case some degradation was detected. The heat-sensitive proteolyic activity was not isolated nor has it been concentrated. Although it is probable that this heat sensitive activity contributes to virus inactivation in marine water, no direct correlation between the biphasic inactivation rates and the proteolytic activity could be made.

ANTIBODY ISOTYPE MEDIATED ANTIGEN RETENTION IN PASSIVELY IMMUNIZED MICE. Richard P. Phipps, G.F.Mitchell*, T.E. Mandel* and J.G.Tew. Dept. of Microbiology, Med. Col. of Va.,Richmond, Va. 23298 and The Walter and Eliza Hall Inst. of Med. Res., Melbourne, Australia.
    Antibody isotypes vary in their capacity to mediate retention of an easily catabolized protein antigen, human serum albumin (HSA), in spleen and popliteal lymph node follicles and collagenous tissues in hind feet. Hyperimmune murine anti-HSA sera were separated into fractions highly enriched for IgM, IgG, and IgG, via differential elution from staphylococcal protein A-sepharose. Fractions obtained were used to passively immunize normal mice, followed 24 hours later by radioiodinated HSA injected into the hind foot pad. The amount of HSA retained in these tissues was determined 6 days later when HSA was localized in lymphoid follicles and collagenous tissues of the hind feet.
    The ability of fractions to mediate HSA retention in splenic follicles could be ranked $IgG_2=IgG_1>IgM$. Autoradiography confirmed this localization pattern. In PLN the pattern was similar except that IgM containing fractions mediated HSA retention to a high degree. In tendons of the hind foot, IgG, mediated HSA retention 5 times better than IgG_2 or IgM fractions. The amount of radioactivity in the liver varied inversely with HSA retention in other sites. The results show differences in antibody isotype requirements for antigen localization in spleen and PLN follicles and in particular collagenous tissues of the hind foot.

DETERMINANT SPECIFICITY OF ANTICATALYTIC ANTIBODIES SPECIFIC FOR HORSERADISH PEROXIDASE. R.D. Salter*, D.C. Borzelleca*, and J.M. Conroy. Dept. of Biology, Microbiology Section, Va. Polytechnic Inst., Blacksburg, Va, 24061

Rabbit antisera specific for horseradish peroxidase were fractionated by absorption with altered enzyme forms and other plant peroxidases to determine the nature of the enzyme sites that bind anticatalytic antibody. While apoperoxidase was immunologically identical to the holoenzyme, the S-carboxymethylated (CM) apoenzyme bound only 30-50% of the total antiperoxidase pool. The antibody unreactive with the CM-apoenzyme retained the anticatalytic activity of unfractionated serum. Similar results were obtained when the apo-enzyme was reduced and alkylated with iodoacetamide. These results suggest that anticatalytic antibodies recognize conformation dependent antigenic determinants. Antibodies specific for horseradish peroxidase cross reacted extensively with carrot, turnip and radish peroxidases. However, only radish enzyme activity was inhibited by antihorseradish peroxidase sera. Fractionation experiments demonstrated that the determinants recognized by inhibitory antibody are present on the radish enzyme but not on the turnip or carrot enzymes.

Further experiments were performed to determine how inhibitory antibody decreases enzyme catalytic activity. These experiments exploited the distinct absorption spectra of native peroxidase and enzyme intermediate forms. The results obtained suggest that anticatalytic antibody does not prevent the formation of the first enzyme intermediate.

BIOCHEMICAL CHARACTERIZATION OF GLYCEROL KINASE FROM PSEUDOMONAS AERUGINOSA. J.R. Sellers,* L.G. Schirch* and S.M. McCowen. Department of Biology and Department of Biochemistry, Virginia Commonwealth University, Richmond, Virginia 23284

Glycerol kinase has been purified from cells of Pseudomonas aeruginosa strain PAO cultured on basal salts medium with glycerol and Casamino Acids as carbon sources. The enzyme was isolated from the 100,000 X g soluble fraction and purified 500-fold by ammonium sulfate precipitation and chromatography on columns of sephadex G-25, DEAE sephadex, hydroxyapatite and sephadex G-200. The enzyme has a molecular weight of approximately 120,000 daltons as estimated by gel filtration.

Kinetic studies indicate that the enzyme phosphorylates glycerol to L-α glycerophosphate by a sequential mechanism. The enzyme exhibited an apparent K_m of $10\mu M$ for glycerol and $100\mu M$ for ATP. Mg^{++} was required for activity although Mn^{++} could be substituted with less activity at equal molar concentrations.

ISOLATION, IDENTIFICATION, AND CHARACTERIZATION OF THE FUNGAL FLORA FROM NORMAL AND DIABETIC HUMAN EYES. R.M. Shaffer*, D.M. Dixon and C.R. Graham, Jr.*, Dept. of Biology, Loyola Col., Baltimore, MD 21210.

The ocular fungal flora of 23 humans was investigated. Corneas of cadaver donors to the Medical Eye Bank,(Baltimore, Maryland) were sampled with sterile cotton swabs prior to removal or disinfection procedures. Swabs were streaked on Sabouraud's and Mycosel agar plates for incubation at 30°C for up to 3 weeks. Eighty-seven percent of the individuals were positive for a total of 42 fungi. Corneas of non-diabetic humans yielded predominately molds (62%), while corneas of diabetics yielded primarily yeasts (58%). In both groups of people, Penicillium and Cladosporium species were the most frequently isolated molds. Other hyphomycetes included Penicillium spp., Fusarium spp., Paecilomyces sp., and Alternaria alternata. Isolates of yeasts from non-diabetic corneas included Trichosporon cutaneum, Aureobasidium pullulans, Candida parapsilosis, and Rhodotorula glutinis. Yeasts from corneas of diabetics included A. pullulans, R. rubra, C. parapsilosis, and Cryptococcus laurentii. Furthermore, twenty-four percent of the fungi were dematiaceous. Forty percent of these failed to liquefy 12% gelatin.

MOLECULAR CHARACTERIZATION OF PLASMIDS DETERMINING COLONIZ-ATION ANTIGENS OF ENTEROTOXIGENIC ESCHERICHIA COLI. T.N. Swanson, A. Allen, P.L. Shipley. Medical College of Virginia Richmond, VA. 23219

Diarrheal disease caused by enterotoxigenic E. coli (ETEC) is mediated by a combination of enterotoxin production and specific adherance to the intestinal epithelium. The K88 surface antigen of E. coli is a fimbriate protein of ETEC strains which allows specific adherance to the porcine intestinal epithelium. K88 is an important virulence determinant, and is coded by transmissible bacterial plasmids.

Mating experiments have been performed capitalizing on the fact that the K88 determinant is associated with genes specifying raffinose fermentation (Raf+). The K88 genes are coded by a 50 Mdal plasmid species which is quite homogeneous for all strains examined. A number of cojugative plasmids are able to mobilize K88-Raf plasmids to recipient strains, in particular a 50 Mdal R-factor specifying tetracycline and streptomycin resistance. Mobilization of K88-Raf plasmids by this transfer plasmid is greatly facilitated by the recA gene of E. coli in donor strains. Transconjugants which contain a 90-100 Mdal cointegrate plasmid are obtained when Raf+ recipients are selected. Restriction enzyme analysis suggests that the two plasmid undergo mutual site-specific recombination at a unique site located within the K88 genetic determinant.Plasmid dissociation within the recipient to the original two 50 Mdal plasmids restores the K88+ phenotype.   (Supported by NIH grant AI15586)

HETEROGENEITY IN ANTICATALYTIC ACTIVITY OF ANTIBODIES SPECIFIC FOR HORSERADISH PEROXIDASE. M.A. Vick*, R.G.B. Roy*, and J.M. Conroy. Dept.of Biology, Microbiology Section, Va. Polytechnic Inst., Blacksburg, Va. 24061

Rabbit antibodies specific for horseradish peroxidase (HRP) are heterogeneous in their ability to inhibit enzyme activity. Heterogeneity was demonstrated by fractionation of the total antiperoxidase pool into antibody subpopulations that differed in anticatalytic activity. The fractionation procedures used were differential ammonium sulfate precipitation of antisera and differential elution of anti-peroxidase from affinity columns containing insolubilized HRP. Some antibody subpopulations decreased catalytic activity almost completely at low molar ratios of antibody to enzyme. Other subpopulations were not efficient inhibitors even at high molar Ab/HRP ratios. Mixing experiments demonstrated that inefficient antibody pools decreased the anti-catalytic effect of highly inhibitory antibody. The degree of inhibition observed with unfractionated antiserum is a reflection of the interaction of various antibody subpopulations with the enzyme. No correlation was found between the immunoglobulin class of antiperoxidase and anticatalytic efficiency in analyses of numerous antisera. The inhibitory efficiency of an antiperoxidase molecule is most likely related to its determinant specificity.

Space Science and Technology

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
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INVESTIGATION OF THE LEADING-EDGE VORTEX FLAP CONCEPT ON A SLENDER DELTA WING. J. F. Campbell and J. K. Huffman, NASA Langley Res. Ctr., Hampton, Va. 23665 and T. D. Johnson*, Kentron International, Inc., Hampton, Va. 23665.

This paper presents experimental and theoretical results on a leading-edge flap device that induces the formation of a vortex along its length through forced separation that acts on the flap to alter the aerodynamic characteristics of slender wings; thus, the name 'vortex flap.' Balance measurements were collected during subsonic wind tunnel tests on a 74° delta model with the vortex flap deflected at both down and up angles and in combination with a trailing-edge flap. Lift performance showed dramatic improvement as the vortex flap deflection angle was changed from 45-deg. down to 15-deg. up, and with increasing down-deflection angles of the trailing-edge flap.

The primary feature of the vortex flap concept is the ability to change the direction of the vortex-induced suction force acting on the flap. Deflecting the flap down results in thrust recovery to enhance maneuver performance, whereas, deflecting the flap up results in higher lift for takeoff and landing operations. Vortex flow theory showed good agreement with the experimental data.

VELOCITY MEASUREMENTS BY ION TRACING IN UF_6. S. S. Fisher and M. G. Hodgins*, School of Engr. and Appl. Sci., U. Va., Charlottesville, VA 22901.

An ion-tracing velocity measurement technique applicable to gases is described. With this technique, ions are produced by focusing a high-power pulsed laser in the gas, thereby inducing electrical breakdown. Ion paths and times-of-flight are then determined by means of a small ion-collector probe. This technique has been used to measure flow speeds and Mach numbers in the far-field (rarefied) regions of low-density free-jet expansions of UF_6 from a converging nozzle. A 4 mJ/pulse nitrogen laser is used. Breakdown is induced in the continuum-flow part of the jet, just downstream of the nozzle exit. Flow-speed measurement precision is approximately 1%. The nozzle Reynolds number range from 100 to 14,000 is covered. The advantages of this technique over other velocity-measurement techniques are discussed.

LOW REYNOLDS NUMBER PITOT-PRESSURE MEASUREMENTS IN FREE-JET EXPANSIONS. G. A. Graybeal* and S. S. Fisher, School of Engr. and Appl. Sci., U. Va., Charlottesville, VA 22901.

The use of a Pitot (impact-pressure) probe as a diagnostic device for low-density supersonic flows is discussed. The problem of interest with such probes is that, at low values of the probe Reynolds number (based on tube diameter and incoming flow conditions), measured Pitot pressures exceed those expected on an ideal basis. Apparatus designed to evaluate this effect for supersonic flows of UF_6 is described. In this apparatus, the gas expands from a converging nozzle into a vacuum chamber, thereby forming a supersonic free-jet expansion. To within good approximation, the variation of the ideal Pitot pressure within these jets is known from other data. The Pitot tube is mounted on a mechanism which allows it to be traversed along the orifice axis and also laterally at constant distance from the orifice center. Probe Reynolds number is varied by varying the probe diameter, the position of the probe in the jet, and the flow stagnation pressure. To some extent, Mach number for the flow approaching the probe can also be varied. A co-objective of this study is to use Pitot probes to more accurately establish density-velocity fields for free-jet expansions.

DETERMINATION OF THE STRUCTURAL DEFLECTION INFLUENCE COEFFICIENT MATRIX FOR SOLID WING MODELS. Sudhir C. Mehrotra*. Vigyan Research Associates, Inc., 28 Research Drive, Hampton, VA 23666

The experimental deflection for a transport-type solid wing model were measured for several single-point load conditions. These deflections were compared with those obtained by structural modeling of the wing by using plate and solid elements of Structural Performance Analysis and Redesign (SPAR) program. The solid element representation of the wing showed better agreement with the experimental deflections than the plate representation. The difference between the measured and calculated deflections is about 5 percent.

MINIMUM NOISE IMPACT AIRCRAFT TRAJECTORIES. R. G. Melton*
and I. D. Jacobson, Dept. of Mechanical and Aerospace
Engineering, Univ. of Va., Charlottesville, Va. 22901
    A flight path modification approach has been used to
minimize the noise impact to a community in the near
terminal area. The measure of noise annoyance used is
Noise Impact Index (NII). Two models of the flight path
have been investigated: 1) a truncated Fourier series and
2) a small number of linear segments connected by circular
arcs. Existing optimization techniques have been employed.
The results of a case study at Patrick Henry Airport are
presented. (Work supported by NASA Langley Research Center
under grant NSG 1509).

EXPERIMENTAL AND THEORETICAL FORCE AND PRESSURE PROFILES
IN A SINGLE DRIVER ACOUSTICAL LEVITATOR. John P. Mugler,
III.* Dept. of Mech. Engr., Univ. of Va., Charlottesville,
Va. 22901
    This paper describes a study of phenomena in a single
driver acoustical levitator. A levitator was designed and
constructed, pressure and force profiles in the levitator
were measured, and the experimental results were compared
to theoretical predictions. Pressure and force profiles
were measured along the vertical centerline of the levita-
tor at sound pressure levels of 140 dB to 154 dB and com-
pared to theoretical predictions. Pressure profiles meas-
ured at a sound pressure level of 150 dB showed that a
pressure well had developed around the horizontal center-
line of the enclosure. The depth of the well and the pres-
sure gradients caused by the well increased with increasing
sound pressure level. Levitational forces up to 170×10^{-5}
Newtons were measured on a 1 inch diameter, $\frac{1}{4}$ inch thick
disk at a sound pressure level of 154 dB. The measured
and calculated pressure profiles showed similar trends, but
also showed substantial differences in the magnitude of the
pressures and pressure gradients, and increasingly poor
agreement as the sound pressure level increased. The meas-
ured and calculated force profiles at a sound pressure
level of 154 dB showed similar trends but the theory gener-
ally underpredicted the measured forces by about a factor
of three.

AEROELASTIC DIVERGENCE EXPERIMENTS ON FORWARD-SWEPT WINGS.
Rodney H. Ricketts*, NASA Langley Research Center, Hampton,
Va., 23665.
    Recently there has been a renewed interest in using
forward-swept wings in airplane designs. To study the
aeroelastic instabilities (divergence and flutter)
associated with these wings, several models were tested
in the 16' Transonic Dynamics Tunnel. Metal plate models
were tested at low speeds to determine the effects of sweep
angle and aspect ratio. Transonic effects were studied
by testing the models to 0.9 Mach number. Airfoil shape
effects were determined to be substantial during the test-
ing of three different airfoil contours, namely, flat-plate
conventional 64A010, and uncambered supercritical. Aero-
elastically tailored composite material models were also
tested at transonic speeds. Test results for one model
agree very well with linear theory predictions because
the model consisted simply of a wing with a very thin air-
foil shape. Test results for another model do   not agree
as favorably. This is attributed to the more complex model
configuration which included a wing with a supercritical
airfoil shape mounted on a fuselage half-body. To safe-
guard the models from destruction during the tests, six
subcritical response techniques were developed and used
to predict the divergence instability before it occurred.

A SURVEY OF SUPERSONIC FLIGHT. M. Leroy Spearman,
Aerospace Technologist, Aeronautical Systems Division, NASA
Langley Research Center, Hampton, Virginia 23665
    Even though manned flight only began early in the 20th
Century, studies of flight at speeds in excess of the speed
of sound (supersonic) were underway before the end of the
first decade of the century. Remarkable progress in the
speed of airplanes and missiles has been made during this
century, including speeds sufficient to provide for flight
into outer space. This paper will provide a survey of the
major milestones in the progress of supersonic flight in-
cluding some of the problems encountered, the solutions
developed, the advent of missiles, some airplane programs
such as the X-series of flight vehicles, the "century
series" fighters, bomber development, the multimission air-
planes, the commercial transport, and some current programs.
The current technology status and the future outlook for
supersonic flight will also be reviewed.

STAGED FUEL INJECTION FOR THE LANGLEY SCRAMJET ENGINE. E.H.
Weidner*, Hypersonic Propulsion Branch, High-Speed Aero.
Div., NASA Langley Research Center, Hampton, VA 23665.
    There is an ongoing effort at the NASA Langley Research
Center to develop a supersonic combustion ramjet (scramjet)
engine that can be used as the propulsion system for hyper-
sonic aircraft. The basic engine is divided into several
identical modules each of which consists of an inlet, fuel
injection struts, a combustor and a nozzle. Gaseous hydro-
gen fuel is introduced into the engine from the struts in
both parallel and perpendicular directions to the primary
flow.
    An important analytic contribution to combustor research
at Langley has been the development of a computer code which
analyzes two dimensionally the flow field near a perpendicu-
lar fuel injector. The program solves the elliptic compres-
sible Navier-Stokes and specie equations using a predictor-
corrector technique. It predicts the turbulent mixing of
fuel and air, and allows the study of separated regions of
flow both upstream and downstream of the injector.
    Presently, the effects of a staged fuel injection system
are being studied using this code. The purpose of staged
injection is to produce an interaction of the separated
regions between the two injectors, optimizing conditions for
flameholding. This paper investigates key parameters such
as fuel split and distance between stages.

Statistics

Fifty-Eighth Annual Meeting of the Virginia Academy of Science
May 13-16, 1980, University of Virginia

THE ONE-TAIL, TWO-TAIL DILEMMA IN HYPOTHESIS TESTING.
Robert L. Andrews, Inst. of Stat., Va. Commonwealth Univ.
Richmond, VA 23284
   In teaching hypothesis testing it is no easy matter to
give clear guidelines for the student to use to decide if
a one-tail test or a two-tail test is the proper procedure.
This paper examines this dilemma and some ethical overtones
that seem to be involved. In conclusion, a straight-
forward alternative is presented that evades this entire
issue.

THE ESTIMATION OF NONLINEAR SYSTEMS OF EQUATIONS. Oral Capps,
Jr.*, Dept. of Agr. Econ., VPI&SU, Blacksburg, Va. 24061
   Many contemporary models of consumer demand comprise com-
plete sets of highly nonlinear demand functions. Consequent-
ly, practitioners are continually faced with theoretically ,
satisfactory models imbued with severe practical difficul-
ties. Estimation methods should take into account parameter
nonlinearity, cross-equation correlation, variance-covari-
ance singularity of the error terms, and various parameter
restrictions. Two potential estimation methods are the max-
imum likelihood procedure and the seemingly unrelated non-
linear regression procedure. This paper gives a theoretical
and empirical comparison of these methods in the estimation
of parameters from complete sets of nonlinear demand func-
tions when the error terms are contemporaneously but not
serially correlated.

AREA ESTIMATES BY LANDSAT: ARIZONA 1979. M. E. Craig,
C. E. Miller. Statistical Research Div., Economics,
Statistics, and Cooperatives Service, U.S. Department of
Agriculture, Washington, D.C. 20250
   This report describes how data from NASA earth resources
monitoring satellites, LANDSAT Il and III, were used in con-
junction with conventionally gathered-ground data to estimate
planted crop areas in the nine southern-most counties in
Arizona. Estimates using LANDSAT and ground data jointly
were more precise than those obtained utilizing ground infor-
mation alone. The major emphasis of the project was to
improve cotton, sorghum and localized corn area estimates.
Availability of LANDSAT data and lack of sufficient ground
data for classifier training hampered the complete success
of the project.
   Key Words: LANDSAT, NASA, cloud cover, regression esti-
mate, direct expansion.

MARKOVIAN TIME-DELAY SAMPLING POLICIES. Y.V. Hui and D.R.
Jensen, Department of Statistics, VPI&SU.
   Let the possible values of the quality characteristics of
a production process be partitioned into k+1 disjoint regions
$\{I_1, I_2, \ldots, I_k, R\}$ reflecting departures of the process
from control, R being the out-of-control state where remedi-
al action is prescribed. A time-delay model for monitoring
the process is developed in which the occurrence of a sample
outcome in the region I_i is followed by a delay of d_i time
units before another sample is taken, the sampling frequency
increasing as the process drifts further from control. The
occurrence of an outcome in R is followed by the lapse of A
time units for adjusting the process before sampling resumes.
   The sampling scheme is formulated as an aperiodic recur-
rent Markov process. The variance and expected number of
samples taken, and the variance and expected number of ad-
justments to the process, are studied for a monitoring per-
iod of length T. Some related models and an extension to
multiple rejection regions are presented. A cost model is
developed for choosing a particular time-delay sampling pol-
icy and for budgeting future sampling efforts under such a
policy.

SOME NEW RESULTS IN THE STATISTICAL INFERENCE OF STABLE LAWS.
I.A. Koutrouvelis*. Dept. of Mathematical Sciences, Va.
Commonwealth Univ., Richmond, Va. 23284

The need to study stable distributions has recently in-
creased, due mainly to the increasing number of applications
these distributions find in many fields. However, inferences
associated with stable laws are especially intricate, as
closed forms for the density functions are non-existent with
only a few exceptions. This paper examines a regression
method of estimation of the parameters which utilizes the
empirical characteristic function. The asymptotic properties
of the estimators are investigated in the special case of
symmetric stable distributions.

THE ANALYSIS OF VARIABLE SELECTION IN LINEAR REGRESSION
ACCORDING TO THE STANDARDIZED TOTAL MEAN SQUARED ERROR.
Yuk-Miu Lam and Raymond H. Myers. Dept. of Statistics,
Virginia Polytechnic Institute and State University, Blacks-
burg, Va. 24061

One of the criteria called the C_p statistic for selecting
appropriate regressor variables in linear regression was
proposed by Mallows (1964). It is an estimate of the stan-
dardized total mean squared error Γ_p defined by

$$\Gamma_p = \Sigma \frac{1}{\sigma^2} E[\hat{y}_{pi} - E(y_i)]^2$$

where $\hat{y}_{pi}$ is the least squares prediction at the ith data
point when fitting a linear regression equation with p vari-
ables. It is suggested that subsets with smaller C_p and C_p
close to p be considered.

In this paper we would construct an approximated confi-
dence interval for the Γ_p and consider various situations in
comparing different regression models in terms of the corre-
sponding Γ_p's. For the simpliest case, we would compare a
p-term model with its subset model, an s-term model by test-
ing H_0: $\Gamma_s \leq \Gamma_p$ vs. H_1: $\Gamma_s > \Gamma_p$. The test would involve a
non-central F-distribution with noncentrality parameter
$\lambda = \frac{p-s}{2}$.

The analysis can be extended to comparing r consecutive
models in which variables chosen have a definite order.

MEASURING AGREEMENT FOR CATEGORICAL DATA: WE GANG AFT AGLEY.
J.E. Mann*, R.S. Schulman*. Dept. of Statistics, Va. Poly-
technic Inst., Blacksburg, Va. 24061.

The measurement of agreement for categorical data is often
based on a k×k table of observed proportions. Such tables
generally arise from the cross-classification of n observa-
tions by 2 judges, or the cross-classification of category
selections by n pairs of observers. In either case the
observed proportion of agreement should be corrected by re-
moving the proportion of agreements to be expected by chance.

Two measures of agreement, involving different corrections
for chance agreement, are discussed. π_A involves a correc-
tion term based on totally random cell assignments, while
kappa employs a correction based on the marginal proportions.
Based on logical considerations and examination of examples,
it is argued that kappa should only be employed when the
experiment involves 2 judges whose category assignments are
constrained by pre-determined marginal distributions. The
main thrust of this argument is that agreement on the margin-
al proportions is part of the notion of agreement, and that
kappa only assesses agreement relative to the similarity of
the two margins.

A BAYESIAN APPROACH TO THE ESTIMATION OF THE SIZE OF WILD-
LIFE POPULATIONS. Philip J. Smith, Dept. of Biostatistics,
Med. Col. of Va., VCU, Richmond, Va. 23298

In the Bayesian context little practical work has been
done with regard to optimization and estimation in multiple
capture recapture surveys. The purpose of the talk is to
present useful Bayesian results regarding these aspects. It
is shown that for most specifications of the loss function,
the Bayesian optimal estimate for the size of the population
resembles the classical Schnabel estimate, thereby attesting
to its efficacy. Also, a framework is given from which the
optimal stage at which to terminate sampling may be obtained.

MARKOV CHAINS AND SEQUENTIAL PROBABILITY RATIO TESTS.
W.H. Woodall and M.R. Reynolds. Dept. of Statistics, Va.
Polytechnic Institute, Blacksburg, Va. 24061

Properties of certain sequential probability ratio tests
(SPRT's) can be determined closely by the construction of
approximate tests for which exact properties can be calcu-
lated using the theory of Markov chains. This approach is
especially useful when the cumulative sum test statistic of
an SPRT is a discrete random variable.

For the approximate Markov chain representation of an
SPRT, exact expressions are presented for the OC function,
the p.m.f. of the decisive sample number (DSN), the fac-
torial moments of the DSN, and the conditional distribution
of the DSN given that the null hypothesis is either accepted
or rejected. The p.m.f. of the DSN is viewed as a generali-
zation of the univariate geometric distribution and its
limiting form for large values can be used to examine the
effects of truncation. A method of constructing bounds on
the OC function of an SPRT is given. These results can be
used to closely determine the optimal stopping bounds of an
SPRT. Convergence properties of the Markov chain represen-
tation of an SPRT are summarized.

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>
> Guliday, John E. 1971. Pleistocene History of the Appalachian Mammal Fauna. *In* Distributional History of the Southern Appalachians, Part III. Vertebrates (Perry C. Holt, ed.), pp. 223-262. VPI & SU, Blacksburg, Va.

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For illustrations, glossy prints are preferred to drawings. Each figure and table should be mentioned specifically in the text, with all figure numbers and legends typed consecutively on separate sheet, and the figures identified by author's name and figure number in pencil on the back. Table numbers and legends should be included as part of the table.

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ARTICLES

On the Teaching of Origins

Michael L. Bentley

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Roanoke Valley Science Museum
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Abstract—Science is empirical and seeks naturalistic explanations for phenomena. Theories must be open to modification based on evidence. The theory of evolution, though it is incomplete, meets these criteria. The movement to require the teaching of creationism in the public schools as an equally valid scientific model is opposed on the grounds that creationism does not meet these criteria of science. Science teachers are advised to teach children the limits of science and the tentativeness of knowledge.

> The human understanding when it has once adopted an opinion draws all things else to support and agree with it.
>
> —Francis Bacon

Knowledge comes to man in many ways. One of the most powerful and successful ways of knowing is science. This is so because science begins with observation and later returns to observation in its method of verification. On the basis of empirical evidence, theories, the products of science, are proposed, and it is through theories that human understanding of nature is advanced. It is assumed, however, that theories only stand for as long as they best explain the evidence. They must be modified when new evidence not explained by them is discovered, or abandoned when better explanations are proposed.

Over a hundred years ago the English naturalist, Charles Darwin, pondered the apparent waste of life in nature. Thousands of frog eggs, for example, yielded only replacement numbers of frogs. This and many other observations eventually led Darwin to propose the theory of the origin of species by natural selection.[1] The key idea of the theory is that such natural selection is the mechanism for changes in the kinds of living things. Given a great number of offspring possessing various traits, those that survive to reproduce are more likely to have traits favoring survival. Over long periods of time and many generations, this differential survivorship yields organisms that are more adapted to the conditions of their surroundings. Organisms that survive will eventually become tuned to their particular environments. As there are many different environments, adaptive changes result in more kinds of organisms; initially simple structures and patterns of behavior become more complex.

Darwin's idea has been so successful that its up-to-date version, the modern synthetic theory of evolution, is now widely recognized as the organizing principle of the life sciences. It is, "perhaps the most important contribution yet made by biologists to our understanding of what the world is like and how it came to be like that."[2] Despite this, the theory of evolution is not complete. Darwin did not understand how variation within species originated. He did not know of genes. Since his time many improvements have been made to the theory with contributions by geneticists, geologists, archaeologists, ethologists, and biochemists, among others. But mysteries still remain to be solved. For example, the explanation of the evolution of life from non-living molecules is far from satisfactory. An organic brew indeed can be concocted in the laboratory by sparking early-earth type gases, but this soup of amino acids would still require an incredible leap to become replicating macromolecules and proteins.

Another gap is in the fossil record. While fossils strongly support the general pattern of evolution, the absence of clear transitional forms is still puzzling. There are also many unresolved problems in dating the ages of rock strata. Different radiometric techniques result in inconsistent ages. Also yet to be accounted for is the amazing perfection of structures such as the human brain. The problem of perfection led to a split between Darwin and Alfred Russell Wallace, co-founder of the theory. Wallace could not bring himself to apply the theory to the human mind, which he viewed as the only divine contribution to the history of life.[3]

Scientists from many disciplines are doing research that could shed light on these unresolved problems, but the basic framework of the theory is firmly intact. There are a small but growing number of scientifically trained individuals, however, that question the very foundation of the theory. Such criticism is not new. The great geneticist, J. B. S. Haldane, wrote twenty years ago:

> The history of science makes it almost certain that facts will be discovered which show that the theory of natural selection is not fully adequate to account for evolution. But the same history makes is extremely improbable that these facts will be in any way related to the criticisms at present made of it. The physics of Newton and Galileo have proved inadequate in several respects, and are being replaced by relativistic and quantum mechanics. These, however, are even further from the medieval physical theories than were the theories of Galileo and Newton.[4]

The current critics are also advancing a very ancient replacement for the theory of evolution, that of Special Creation. The campaign for creationism is being led by three groups: The Creation Research Society of Ann Arbor, Michigan, the Creation Science Research Center and the Institute for Creation Research, both of San Diego. They have created a stir out of proportion to their numbers, not so much in scientific circles but in public education. The stated goal of these groups is that the creation model for the origin of species should be taught in the public schools along with evolution, as equally valid *scientifically*.[5] Their views have attracted much financial support from fundamentalist Christian groups and individuals and they have been able to publish a wide array of literature, produce professional quality films and other media, and engage in nation-wide public speaking tours.

The creationist societies have had successes. Among the states which have adopted an "equal time" policy for science textbooks are Mississippi and Indiana. In other states such as Georgia, Texas, Illinois, and Virginia some local school authorities are requiring the presentation of both evolution and creationism in science classes.

From a realization that the evolution-creation controversy can not be ignored by science educators, I attended a creationist-sponsored conference recently in Raleigh, North Carolina. The reactions and questions from the audience of over three hundred people indicated strong support for the creationist thesis. These supporters included many well-educated people, including science educators at the elementary school, secondary, and college levels. The presenters were Dr. Henry M. Morris and Dr. Gary E. Parker. Dr. Morris' background is in geology, hydraulics, and engineering. He was formerly department head in civil engineering at Virginia Polytechnic Institute and State University. Dr. Parker's training is in biology and science education. No doubt as a result of many such presentations, the alternating speeches of Morris and Parker were polished, pointed, and very convincing. Most of their arguments detailed the shortcomings of the theory of evolution. I had heard most of these before, but never as part of an attack on the basic ideas of evolutionary theory. Some time was also spent describing the creation model, which agrees literally with the Biblical account of creation. This model is "scientific" because it accepts that science has learned more about nature since Biblical times. Hence DNA, mutations, and the fossil record must be accounted for, and the creation model does so, the adherents contend, better than the theory of evolution.[6]

It is not the intent here to respond to the arguments for or against either model. I instead want to address the goal of this movement, i.e. to include creationism with evolutionary theory in the school curriculum as a scientifically valid explanation of natural phenomena. I believe this must be resisted by science educators. At first sight it might appear fair and unobjectionable to present children with the evidence for both ideas about origins, but the creationist model simply does not have

the same kind of scientific validity as the theory of evolution. That is not to say that it can not be a true account of the origin of life; it could. However there are three reasons why creationism isn't *scientific*. First, the theory was not constructed from observations. The creationists started with the full-blown theory, the Genesis account, and then fit evidence into the theory. This is the opposite of the way science proceeds. Second, since most creationists interpret scripture literally and hold it as the immutable word of God, they would likely be unwilling to modify their theory regardless of new evidence. This, again, is the antithesis of science. Science values open-mindedness, even though scientists themselves are human and can be just as blind and stubborn as anybody. Third, the creationist model violates "Occam's razor." *"Pluralitas non est ponenda sine necessitate,"* or "make no more hypotheses than necessary," said William of Occam. This basic principle of science is transgressed when causes outside of nature, supernatural causes, are invoked for explanations. This is not to say that a supernatural being could not have created the universe, but that it cannot be defended as a *scientific* account. The origin of life took place long ago and no theory as to how it happened can ever be tested in a laboratory sense. Nevertheless the theory of evolution is in every sense a scientific theory: it has been built from observations; it has already been modified many times to account for the evidence and it is open to further modification; and it seeks naturalistic explanations for observed phenomena. For these reasons the evolutionary explanation, despite its incompleteness, is a scientific explanation. Creationism, failing on all three, is not.

The creationists do make a very important point. The theory of evolution should not be taught in school as fact. Children should learn in science classes the assumptions upon which the theory is based. They should be made aware of its shortcomings. They should, in fact, learn to appreciate the tentativeness of *all* scientific knowledge. Science *does* have limitations. There is no question but that teachers of science have been remiss on this account, perhaps a reflection of their own misunderstanding of science. It is only when one understands the limits of science that its power becomes clear.

Footnotes

[1] Charles Darwin. *The Origin of Species,* 6th ed. (Harmondsworth: Penguin Books, 1968).

[2] John Maynard Smith, *The Theory of Evolution,* 3rd ed. (Middlesex, England: Penguin Books, 1975), p. 9.

[3] Stephen Jay Gould. *Ever Since Darwin* (New York: W. W. Norton & Company, 1977), p. 25.

[4] J. B. S. Haldane, "Natural Selection," in *Darwin's Biological Work,* ed. by P. R. Bell (New York: John Wiley & Sons, 1959), p. 148.

[5] Morris, Henry M. *The Remarkable Birth of Planet Earth* (San Diego: Creation Life Publishers, 1972).

[6] R. B. Bliss. *Origins: Two Models: Evolution, Creation* (San Diego: Creation Life Publishers, 1976).

Aflatoxin Occurrence in 1977 Corn in Virginia

Gerald C. Llewellyn and Judith S. Katzen

Department of Biology
Virginia Commonwealth University
Richmond, Virginia 23284

Abstract—A review of aflatoxin contamination of corn and how it relates to Virginia and the Southeastern corn belt is presented. Data for aflatoxin levels in Virginia corn samples are reported and analyzed beginning with the 1977-1978 crop year. Extensive analysis of Virginia corn for aflatoxin was initiated following a survey conducted to determine the extent of aflatoxin contamination in corn produced in Virginia. A free testing service for Virginia producers and users was provided. Approximately 1000 samples were collected according to certain specifications and then shipped to the Division of Consolidated Laboratory Services in Richmond for analysis. Screening for aflatoxin was accomplished by the mini-tube method. Results were divided as to samples containing 0 to 20 ppb aflatoxin, 21° to 100 ppb, 101 to 400 ppb, and greater than 400 ppb total aflatoxin. An attempt was made to correlate these results and the location in the state in which the corn was grown. It seemed, according to this data, that the Tidewater and Northern Virginia regions had the greatest problems. These problems correlated with a drought-wet sequence in climatic conditions. Air temperature did not appear to contribute to the problem. These climatic conditions, possibly in conjunction with insect damage, appear to be unique for the crop year of 1977-1978.

Introduction

Aflatoxin is a problem as a contaminant of many agricultural products. *Aspergillus flavus*, the toxigenic mold that produces aflatoxin, grows on many plant produts. Corn tends to be one of the primary targets for both the fungus and its toxin (Golumbic and Kulik, 1969). A correlation to the problem can be made between aflatoxin occurrence and geographical regions. The problem becomes even more important when the widespread uses of corn are recognized.

Large populations of animals and humans consume diets including corn. Tortillas are made in most Latin American countries and are even becoming the fad in fast food restaurants in the United States. Corn is important to swine production (Jensen *et al.*, 1977) and to other animal feeds. Corn is also used for milling and brewing as well as for export. Hence, if large quantities of aflatoxin are found, there is a possible bioconcentration problem for humans.

Prior to 1970, little was known about aflatoxin. However, its frequency was sufficient to cause some concern. As early as 1963, Spensley (1963) felt there was no real danger as long as proper steps were taken to ensure little or no mold proliferation. It was found that optimum conditions for fungal growth was a temperature of 30°C and a humidity level of 80-85%. Also a moisture content of the substrate in the range of 15-28% was needed.

The earliest tests evaluating aflatoxin in corn were made in 1964, 1965, and 1967 on all grades of corn in the Midwest or Cornbelt. There was very little incidence of aflatoxin (2.1-2.3%), with a range of 3-37 ppb from all the contaminated samples, and these only from the lower grades of corn (Shotwell *et al.*, 1969; Shotwell *et al.*, 1970).

Then in 1968-1969, a survey was conducted on export corn from ten ports on all grades except U.S. #1. Again the poorer grades contained the toxin and only in small quantities; 2.7% was contaminated and contained 6-25 ppb (Shotwell *et al.*, 1971).

However, it should be noted that in those early years there was a cause for concern in the southern United States that has continued through the present time. This illustrates the fact that the aflatoxin problem is somewhat regional. In 1969 and 1970, crop samples taken in North Carolina, South Carolina, and Virginia were all aflatoxin-negative. The following year, 14 out of 22 samples were aflatoxin-positive and 12 samples contained greater than 20 ppb. It also can be noted from these studies that the samples with the highest toxin levels were from the lowest grade of yellow corn and were in corn with a moisture range of 19.1-20.6% (Shotwell *et al.*, 1973).

More studies were made on corn by regions. Rambo *et al.* (1974) tested preharvest yellow and white dent corn during 1971 and 1972 from Indiana and Kentucky. Those samples taken in 1972 in Indiana were tabulated by regions also: northern counties, central counties, southern counties, and Evansville, Indiana. A total of 0.11% of the kernals were infected and these were found only in the southern counties and Evansville. Although there was an increase over the previous year's incidence, the increase only amounted to 1.0%

Shotwell *et al.* (1971, 1978) also made studies in the Midwest. They found in Missouri in 1971 that 13% of the aflatoxin-contaminated corn exceeded 20 ppb. The most recent studies involved Illinois, Indiana, Iowa, Kansas, Nebraska, Ohio, and Wisconsin. Of the 923 samples taken, only three contained aflatoxin at levels over 20 ng/g. Those violating the Food and Drug Administration's guidelines (> 20 ppb) comprised only 0.3%, and only 0.6% contained detectable levels.

While aflatoxin levels in corn from the Midwest appear to stay relatively low (usually 2-3% with only a trace amount of samples containing greater than 20 ppb), such is not the case in the South. From samples taken during 1969, 1970, 1971, and 1973 throughout

the South, levels exceeding 20 ppb ranged from 13-32% (Shotwell, 1977). For other samples taken in Virginia during 1976, 27% exceeded 20 ng/g. The state of Georgia seems to have the most severe problem. In the 1977-1978 crop season, 75% contained greater than 20 ppb and 25% surpassed 400 ppb (Brown, 1978).

In light of all these studies, definite conditions for the growth of *A. flavus* and aflatoxin production have been documented. Primary occurrence of the toxin begins in preharvest corn, although a storage problem is possible (Goldblatt *et al.,* 1977). As noted earlier, fungal growth and resultant aflatoxin synthesis needs high moisture levels. Also related are a heavy insect population and resultant damage, or dought, then a wet harvest period with concurrent insect damage (Brown, 1978). In addition, causitive agents include wind spreading of *A. flavus* spores, rough handling of corn during harvest, and geographical location, which cannot be divorced from the problems caused by high moisture content and weather conditions.

Storage conditions can also cause problems when the outside bins in which the corn is stored gathers moisture around the windows, probably contributing to the occurrence of a "hot spot". In these areas, moisture levels and mold levels become sufficiently high to cause substantial aflatoxin in the center of the "hot spot" (Hesseltine, 1974).

However, with the development of rapid testing procedures and detoxifying methods, some concern about aflatoxin could be reduced. There are three basic analyses for aflatoxin. The first is a rapid presumptive test by visual inspection under longwave ultra-violet light. A positive test shows a BGYF, bright greenish-yellow fluoresence (Shannon *et al.,* 1978). This method is not very reliable as aflatoxin may form beneath the testa and the BGYF may not show up. Therefore, when this testing is attempted, the kernal and other parts of the plant should be coursely ground. Also, once a positive test shows, a quantitative method is in order. The second parameters are rapid screening procedures to confirm the toxin's presence (qualitation), but not levels (quantitation), and usually use the glass minicolumn and thin layer chromatography (TLC). A final parameter is a chemical test for actual quantitative measurements.

Methods of detoxifying that have been tried include ammoniation of corn. This significantly reduces the aflatoxin. When feed that has undergone ammoniation is supplemented with non-ammoniated, noncontaminated corn, swine show no difference as to preference over non-supplemented, non-contaminated corn (Jensen *et al.,* 1977). Other methods include alkaline treatment with calcium hydroxide, as is used in the making of tortillas (Ulloa-Sosa *et al.,* 1968).

For the entire aflatoxin problem, prevention of the mold growth would be the best approach. Insecticides reduce but do not eliminate toxin occurrence (Lillehoj *et al.,* 1976). Also, possibilities include a choice of hybrid crops that tend to be resistent in certain geographic areas which can be coupled with a program for insect control. Finally, avoidance of excessive water

accumulation in stored corn may not prohibit aflatoxin altogether, but it may provide the farmer with sufficient usable feed for livestock or a profitable business in corn (Lillehoj *et al.,* 1976, 1978).

It became evident in the fall of 1977 that a high incidence of aflatoxin contamination of corn was occurring in the Southeast. The state of Virginia became aware of this and began the analysis of newly harvested corn. Virginia ranks 20 out of 41 states producing corn. This represents 0.75% of the corn production in the U.S. for grain. In the state of Virginia, corn produced for grain ranks second to tobacco in money value (Schooley *et al.,* 1976). Geographically, Virginia is considered one of the northern most states in the southern corn producing area. Also, there is adequate evidence that toxigenic mold is present in the agricultural areas of the state. Evidence to support this includes the continued low level contamination of peanuts produced in the state (Sledd *et al.,* 1976). Some areas of the state produce both corn and peanuts.

The data presented and analysed herein will be based upon a six month study of approximately 1,000 samples of corn from the state of Virginia that were analysed for aflatoxins. An effort was made to correlate rainfall, geographic regions, and the number of samples contaminated with various levels of aflatoxin. This study was undertaken in the fall of 1977 when the Southeast appeared to have its most extensive occurrence of aflatoxin-contaminated corn known in recent history.

Materials and Methods

History and Preliminary Tests

The Mycotoxin Laboratory of the Virginia Division of Consolidated Laboratory Services began a program of testing for aflatoxin in corn at the request of the Marketing Division of the Virginia Department of Agriculture on September 1, 1978. The purpose of the survey was to determine the extent of aflatoxin contamination in corn being marketed in Virginia. The samples were collected from grain dealers and buying stations to determine generally the situation in Virginia. It was soon recognized from the survey results that there was a need to provide a testing service for Virginia producers and users in order that they may be better informed. On September 30, 1978, the Commissioner of Agriculture and Consumer Services requested of the Director of Agriculture and Natural Resources at Virginia Polytechnic Institute and State University (VPI & SU) that a service testing program be implemented through the extension service. Early in October, the Cooperative Extension Service of VPI & SU announced to all corngrowers and others buying or feeding corn the procedure for free testing as outlined by the Virginia Department of Agriculture and Consumer Services. Instructions were given for sampling, shipment, sample identification and reporting of results. As a result the state soon began testing corn samples sent not only by the Marketing Division but

by the extension agents, Agriculture and Soil Conservation inspectors, Virginia food and feed inspectors, and individual farmers, millers, farm bureaus, veterinarians, and the Virginia Department of Animal Health and Dairies.

Procedures for testing were carried out in several steps. The first step involved sampling the corn, with as much representation as possible assured by the corn being taken from many areas within the lot. Also the sample size had to be a minimum of two pounds and a maximum of three pounds. Next came shipping in plastic bags that had been adequately packaged for mailing to: Division of Consolidated Laboratory Services, 1 North 14th Street, Room 350, Richmond, Virginia 23219. Sample identification followed such that, a) all samples were identified as corn for aflatoxin analysis, b) lot number, bin number, *etc.* were used so that the report could be related to an identified lot of corn, c) all names and complete mailing addresses of all persons who were to receive a copy of the laboratory report had to be included, along with d) the name of the county in which the corn was produced.

Laboratory findings were reported in the following ranges: 1) none detected, 2) less than 20 parts per billion (ppb), 3) 21 to 100 ppb, 4), 101 to 400 ppb, 5) greater than 400 ppb. These reports were sent to the extension agents and others requesting this information. Finally, these results were interpreted as follows: a) corn containing less than 20 ppb aflatoxin can be used for human consumption and can be fed to all animals regardless of size or maturity, b) corn with more than 20 ppb should not be used for human food or fed to dairy animals or sows suckling their young, c) corn having 21 to 100 ppb aflatoxin can be fed to mature beef animals, poultry and swine (Mature animals are considered to be those beyond the age where a starter ration is normally fed.), and d) corn found in excess of 100 ppb should not be fed to animals of any size or stage of maturity since evidence exists that feeding corn such as this can cause decreased feed efficiency, depressed growth rate, lesions on the liver and kidneys, and possible residues of aflatoxin in meat, milk, or eggs.

Quantitation of Aflatoxin Levels

The testing of corn for aflatoxin was done at the Virginia Division of Consolidated Laboratories by the mini-tube method (Romer, 1975). This method has been adopted as an official first action method the Association of Official Analytical Chemists and appears in the official manual as Minicolumn Detection Method 26.A01-26.A08. Positive samples of less than 20 ppb are not given a quantitative measurement by TLC. Likewise, samples of 21 to 100 ppb, 101 to 400 ppb, or greater than 400 ppb are not measured by TLC unless they are official state samples requiring regulatory action. In the latter case two determinations of a second portion of the sample are run before reporting the test results.

Only corn samples known to be grown in Virginia were reported in this study. Also the preliminary study by the Marketing Division was not included since it lacked specific data such as origin of the corn.

Results

Climatological Data

Virginia was divided into six regions with titles that describe the geography of their respective land. Moving from the western part of the state to the western and finally southeastern part are Tidewater, Eastern Piedmont, Western Piedmont, Northern, Central Mountains, and Southwest Mountains (Fig. 1). Since drought may be a factor in aflatoxin generation, two of these areas, Tidewater and Northern were studied in 1977 as to their precipitation deviations from means in inches and temperature in degrees Farenheit (Smith, 1977) during the months that correspond to the season of growth-to-harvest of corn (Table 1). Total precipitation for this period deviated from the mean by -0.18 in Tidewater and -0.19 in Northern region, while the temperature was above average for both areas.
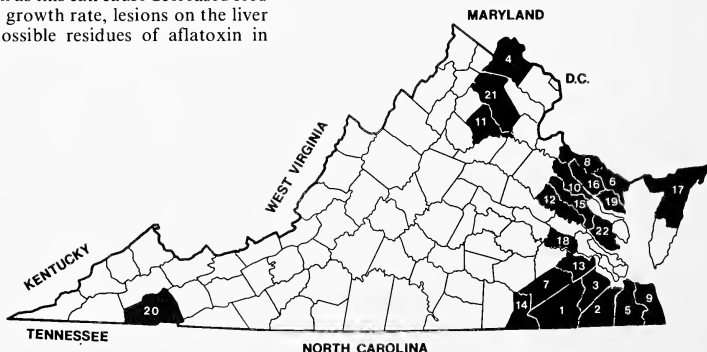
FIG. 1—Geographic location of the top 22 corn producing counties in 1976 in Virginia. Eighteen counties were in the Tidewater Region, three in the Northern Region, and one in the Southwestern Mountain Region.

Table 1. Precipitation with accumulations and air temperature deviations from the normal for two regions
          in Virginia (1977).

Parameters	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Mean Deviations
				Tidewater Region					
Precipitation (inches)	-0.47 (accum.)	0.47 (0.00)	-1.55 (-1.55)	-1.75 (-3.30)	-1.48 (-4.78)	-1.23 (-6.01)	2.95 (-3.06)	1.62 (-1.44)	-0.18
Temperature (°F)	3.0	0.6	-1.7	2.3	2.7	2.8	-2.8	2.1	1.13
				Northern Region					
Precipitation (inches)	-0.38 (accum.)	-2.20 (-2.58)	-1.46 (4.04)	-0.62 (-4.66)	-0.84 (-5.50)	-0.86 (-6.36)	1.27 (-5.09)	3.56 (-1.53)	-0.19
Temperature	2.3	2.1	2.3	2.0	1.3	1.9	-3.7	1.2	1.16

Table 2. Production of corn in most Virginia counties during 1975 and 1976 crop years[a].

Rank	1975 County	Bushels (10^6)	1976 County	Bushels (10^6)
1	Southampton	2.85	Southampton	4.16
2	Isle of Wight	2.23	Suffolk City	2.75
3	Suffolk City	1.85	Isle of Wight	2.49
4	Loudoun	1.50	Loudoun	1.93
5	Westmoreland	1.46	Chesapeake City	1.49
6	Sussex	1.43	Northumberland	1.32
7	Surry	1.39	Sussex	1.28
8	Northumberland	1.31	Westmoreland	1.27
9	Culpeper	1.26	Va. Beach City	1.26
10	King William	1.09	Essex	1.15
11	Chesapeake City	1.09	Culpeper	1.10
12	Essex	1.06	King William	1.09
13	Va. Beach City	1.06	Surry	1.02
14	Richmond	1.04	Greensville	0.97
15	Fauquier	0.93	King and Queen	0.96
16	Accomack	0.93	Richmond	0.89
17	King and Queen	0.93	Accomack	0.84
18	Pittsylvania	0.90	Charles City	0.81
19	Rockingham	0.89	Lancaster	0.79
20	Augusta	0.89	Washington	0.78
21	Halifax	0.84	Fauquier	0.76
22	Madison	0.79	Glouster	0.68
23	Hanover	0.78	Pittsylvania	0.65
24	Caroline	0.76	Madison	0.64
25	Lancaster	0.73	Halifax	0.63
26	Mecklenburg	0.73	Rockingham	0.61
27	Orange	0.72	Middlesex	0.61
28	Gloucester	0.69	Augusta	0.59
29	Greensville	0.68	Orange	0.56
30	Prince George	0.68	Prince George	0.53
31	Charles City	0.67	Hanover	0.53
32	Dinwiddie	0.60	Caroline	0.48

[a] From: Virginia Agricultural Statistics, Bulletin No. 42, Sept. 1977, Va. Cooperative
         Crop Reporting Service, Richmond, VA

Table 3. Distribution groups showing
          the number of corn samples
          submitted on a county basis
          (Sept. 1, 1977-March 2, 1978)[a].

Number of Samples Submitted	Number of Counties Submitting Samples	Percent of all Counties Submitting Samples
1-5	31	39%
6-10	14	18%
11-15	12	15%
Subtotal	57	73%
16-20	5	6%
21-25	6	8%
26-30	4	5%
31-35	3	4%
36-40	1	1%
41-45	0	-
46-50	0	-
51-55	1	1%
56-60	1	1%
61-65	0	-
66-70	1	1%
Subtotal	22[c]	27%
Total[b]	79	100%

[a]A total of 70 counties or cities submitted
samples for analysis.

[b]A total of 997 samples were tested.

[c]665 of the 997 samples were from these
22 counties.

Harvest and Infestation Data

In 1976, Virginia corn for grain shows 615,000 acres harvested with a production value of $119,187,000. According to the Virginia Cooperative Reporting Service (Schooley *et al.,* 1977), corn for grain was the second ranking crop in the state, competing with hay and tobacco. In comparison to corn for grain produced by other states, Virginia ranks 20th out of 41 corn producing states, and Virginia constitutes 0.75% of the total U.S. production. Virginia sweet corn production is substantially smaller than corn for grain. In 1976, it was grown on 1,400 acres, ranked 15 in the state, and had a production value of $1,688,000. Nationally sweet corn production rank was 16th in 17 producer-states and amounted to 0.96% of the total produced in the U.S.

From Table 2 and Figure 1, the rankings and quantity for corn production of all the counties in Virginia and the top 22 counties, respectively, can be seen. It can also be noted that the top ranking counties are found primarily in Tidewater and Northern regions. Table 3 gives the distribution groups on a country basis showing the number of corn samples submitted for aflatoxin testing as reported in this study.

Starting with Table 4 and Figure 2, the rankings of the counties within the state and their corresponding levels of contamination in parts per billion are also revealed. Table 5 represents the rank of counties with primarily 101-400 ppb but also includes other levels. Again it should be noted that these are located primarily in Tidewater.
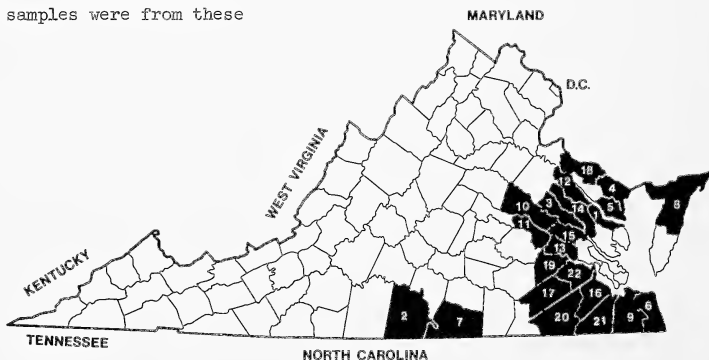
Fig. 2— Rankings by number for the top 22 counties submitting samples that exceed 20 ppb aflatoxin. Only counties submitting 16 or more samples are included. They involve three Eastern Piedmont counties (7, 10, & 11), one Western Piedmont county, the rest are in the Tidewater Region.

Table 4. Ranking of all Virginia counties submitting samples and having > 20 ppb aflatoxin (Sept. 1, 1977-March 2, 1978)[a].

City or County	% Submitted Samples Contaminated[b]	Number of Samples Tested
Buckingham	100%	2
Brunswick	67%	6
Charlotte	67%	6
Middlesex	56%	18
Lunenburg	50%	14
Gloucester	42%	14
Halifax	42%	24
Northumberland	36%	28
King William	35%	17
Stafford	33%	3
Lancaster	32%	25
Virginia Beach (City)	31%	26
Richmond (County)	31%	13
Northampton	29%	14
Matthews	29%	7
Mecklenburg	29%	34
Pittsylvania	27%	11
Accomack	25%	20
Amelia	25%	4
Caroline	25%	4
Chesapeake (City)	25%	20
Franklin (County)	25%	4
James City	25%	8
Nottoway	25%	4
Hanover	24%	54
Henrico	23%	22
Dinwiddie	21%	14
Essex	21%	28
Greensville	21%	14
Washington	20%	10
Cumberland (City)	20%	5
Charles City	19%	69
King and Queen	18%	22
Page	17%	6
New Kent	15%	39
Richmond (City)	14%	14
Petersburg (City)	13%	8
Sussex	13%	24
Isle of Wight	13%	60
Westmoreland	12%	25
Prince George	10%	29
Carroll	8%	13

[a]Total of 42 counties or cities submitted samples.

[b]Mean percent with standard deviation: 28.9±17.6.

Table 5. Virginia counties having samples of corn containing various levels of aflatoxin (Sept. 1, 1977-March 2, 1977).

County	101-400 ppb	(%)	(Rank)	>400 ppb	21-100 ppb	<20 ppb
Charles City	2/69[a]	2.9	14	-	11/69	26/69
Chesapeake (City)	1/20	5.0	9	-	4/20	7/20
Essex	2/28	7.1	7	-	4/28	11/28
Halifax	2/24	8.3	5	-	8/24	2/24
Hanover	2/54	3.7	11	-	11/54	23/54
Isle of Wight	2/60	3.3	13	-	6/60	2/60
King William	2/17	11.8	4	1/17	3/17	4/17
Lancaster	1/25	4.0	10	-	7/25	9/25
Middlesex	4/18	22.2	1	-	6/18	5/18
Northampton	1/14	7.1	8	-	3/14	3/14
Northumberland	6/28	21.4	2	-	4/28	7/28
Prince George	1/29	3.4	12	-	2/29	8/29
Richmond (County)	1/13	7.7	6	1/13	2/13	5/13
Washington	2/10	20.0	3	-	-	-
New Kent	0/39	-	-	1/39	5/39	10/39
Total (15)	29/339[b]					

[a]Samples/total samples tested from that county is given.

[b]When compared to the total samples tested in Virginia (29/997)=2.9% had 101-400 ppb.

A summary of the number of counties submitting samples, levels of contamination, and percentages is found in Table 6. More than 15.5% of the samples tested fell specifically within the Virginia limited-use guidelines, while approximately 81% of the corn tested fell with FDA guidelines (contain less than 20 ppb). Only 3.2% is not usable by FDA or Virginia guidelines.

Table 6. Summary of counties submitting samples, levels of contamination, and corresponding percentages.

Counties Submitting Samples	Total Samples Tested	None Detected	<20 ppb	21-100 ppb	100-400 ppb	>400 ppb
79	997	572	236	157	29	3

Counties Growing Corn	% of Counties Submitting Samples	% ND	%	%	%	%
97	81.4	57.4[b]	23.7[b]	15.7[c]	2.9[d]	0.3[d]

[a]Had a minimum of 200 acres of corn in 1975 and 1976.

[b]81.1% of the corn tested fell within FDA guidelines.

[c]15.7% of the corn tested fell within VA limited use guidelines (total of 96.8% usable)

[d]3.2% of VA corn tested was not usable.

Discussion

It is evident that Virginia did have an aflatoxin problem as illustrated by approximately 1000 samples tested. This problem follows the pattern thus far seen in several areas in the United States in that it was regional, becoming acute in specific counties, and it seemed to relate positively to a sequence of drought followed by increased wetness.

Drought is defined by Palmer (Smith, 1977) as a "prolonged and abnormal moisture deficiency". Indicative of normal moisture or wet conditions are the index values on the positive side, while negative values

correspond to the drought severity. Negative precipitation values for both monthly and accumulative data are reported in Table 1. It can be noted that there was a drought in these counties in Virginia during this time. When considering some counties with a notable aflatoxin problem in corn in Tidewater and Northern regions, both of which had a concurrent problem, the above mentioned sequence of drought followed by a wet period was seen. Notwithstanding, it does appear that temperature as mentioned by deviations from the mean is not as important as precipitation. Eighteen of the 22 top corn producing counties are located in Tidewater and three are located in the Northern region. Therefore, most of the corn produced in Virginia was exposed to drought.

The Tidewater region is implicated as a major area for aflatoxin contaminated corn when 20 of the top 22 counties submitting 16 or more samples had greater than 20 ppb aflatoxin and fall within this region. The top five counties are also located in Tidewater. When considering samples of greater than 20 ppb, the trend continues. For example, Richmond County, which did not achieve the 15 sample cutoff (having only 13 samples of which 4 contained in excess of 20 ppb), would show a 31% level of contamination. The fact that Richmond County is included in Tidewater supports the concept, but it was not counted. Also, when evaluating Figure 4, which involves all aflatoxin-positives, again it is seen that only two counties (possibly three), one in each of the two mid-quartiles, that are not in Tidewater.

In the summary data, it is seen that 97 counties grow corn with 79 submitting samples. Eighty one percent of the corn samples tested fell within FDA guidelines, meaning that they had less than 20 ppb. Also, 572 out of 997 or 57.4% had absolutely no aflatoxin detected in the corn. Falling within the Virginia limited-use guidelines were 96.8% of all samples tested. Essentially then, only 3.2% of the corn tested was not usable.

In looking at the breakdown of the contaminated corn samples, it is evident that 23.7% of the samples had between 0 and 20 ppb. From 21-100 ppb were found in 15.7% of all samples tested, decreasing to 2.9% for 101-400 ppb; and only 0.3% contained an excess of 400 ppb.

The following data is seen concerning counties with high levels of 101-400 ppb. Middlesex led the counties with 22%, Northumberland had 21.4%, Washington had 20%, King William had 11.8 and almost 6% had an even greater amount. Rounding out the top 10 counties in order are Halifax (8%), Richmond County (7.7%), Essex and Northampton (7.1%), Chesapeake City (5%), and Lancaster (4%). All of these counties but Northampton and Halifax are located in Tidewater while these two are located in the Southwest Mountain and Western Piedmont regions, respectively.

In comparison to other southern states as reported by Shotwell (1977), Virginia had a mild aflatoxin problem. However, when comparing previous samples in Virginia and the Midwest, Virginia did have a greater problem during the crop year 1977, therefore, it appears that for that year, upon proceeding southward on a state by state basis, the more critical and the greater the aflatoxin problem became. This is substantiated by reports coming out of Georgia and Florida (Shotwell, 1977; Brown, 1978).

Virginia did have a problem in 1977 compared to its own base line in previous years. The primary parallel sequence that occurred, which may have contributed to this problem, was a slight, but not severe, drought followed by a wet fall (as measured by precipitation). Air temperature did not appear to be as important or deviate from normal. Probably during the drought, insect damage contributed to the problem, as has been noted in other areas by Lillehoj (1978). This idea by itself needs further study. Finally, it is of interest to note that aflatoxin levels in corn returned to normal in the crop year 1978, and as expected, the 1978 crop-year lacked the drought-wet sequence. Even though slight deviations with temperature were evident, it appears that the necessary temperature range was available to allow the mold to produce the toxin.

Although this paper primarily deals with the crop year 1977, further testing was done by the Department of Agriculture and Consumer Services for the next two crop years. Aflatoxin was found to be present in the corn during these terms, but it was in significantly lower amounts. Also, it should be noted that there was a change in the location of the aflatoxin problem during 1979 which may have been the result of a wet harvest period in that area.

During the 1978 crop year, out of 386 samples submitted, 286 or 74.1% contained no aflatoxin. Sixty samples or 15.54% contained 20 ppb, 29 (7.51%) contained 21-100 ppb, and 101-400 ppb aflatoxin were found in only 11 samples for a mere 2.85%.

Thirty five counties submitted 246 samples for the 1979 study. Only 19 samples were found to be contaminated; however, 15 of these were found from three Central Mountain counties (Augusta, Rockingham, and Shenandoah). Of the 15, 60% (9 samples) contained 0-29 ppb, 27% (4 samples) had 21-100 ppb, and in the remainder, no aflatoxin was found.

Regulatory officials, agribusinessmen, and farmers, therefore should be alert to a potential aflatoxin problem when the drought-wet sequence, occurring with normal summer temperatures becomes conducive to allow such a problem to develop. This seems especially relevant for the Tidewater region.

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Phrymaceae and Plantaginaceae in Virginia

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Abstract—Phrymaceae (1 species) and Plantaginaceae (9 species) are studied floristically in Virginia. A new key to species of *Plantago* is provided. *Plantago wrightiana* is reported new to the Virginia flora and *Plantago cordata* is verified in the flora with specimen citations. Descriptions of all taxa, ecological data with dot maps, flowering and fruiting times and chromosome numbers, where known, are included.

Introduction

This paper is based upon field work and study of about 560 specimens from the following herbaria: George Mason University, Lynchburg College, Old Dominion University, University of North Carolina, U.S. National Herbarium, Virginia Commonwealth University, Virginia Polytechnic Institute and State University, West Virginia University, and the College of William and Mary. *Plantago cordata* was seen from the Missouri Botanical Garden, St. Louis, and from the New York Botanical Garden, Bronx, NY.

Phrymaceae, a monotypic family, occurs from India to Japan and in the eastern United States. It is represented in Virginia by *Phryma leptostachya*.

Plantaginaceae, consisting of three genera and about 270 cosmopolitan species, is represented in the Virginia flora by 9 species of *Plantago*.

Taxonomic Treatment

The Phrymaceae were placed taxonomically near Plantaginaceae in earlier works (Fernald, 1951; Gleason and Cronquist, 1963). More current work indicates a closer relationship with Verbenaceae (Takhtajan, 1969; Cronquist, 1968; Radford, et al., 1968) with the major distinguishing feature being the biovulate carpel in Verbenaceae vs. a single ovule in Phrymaceae.

Nomenclature follows Radford, et al. (1968) and Bassett (1966, 1967). Synonymy is not dealt with.

Phrymaceae

1. *Phryma leptostachya* L. Lop-Seed.

Perennial herb 2.2 - 9 dm tall, simple or less commonly branched; leaves opposite, thin, ovate, the largest or middle leaves (3.4-) 7.5 - 16 (-20.5) cm long, (2-) 3.1 - 8 (-9) cm wide (measurements include blade and petiole), crenate to doubly crenate, nearly glabrous, the apex often long attenuate; flowers borne on pedicels ca. 1 mm long in a raceme, buds erect, flowers horizontal or ascending, fruits strongly reflexed; sepals united, 2-lipped, the upper with three usually reflexed triangular lobes, the lower with 2 lobes; corolla lavender, ca. 5 mm long, 2-lipped, the upper lip a single acute lobe, the lower 3 rounded lobes; stamens 4, included; ovary superior; fruit a single seeded nutlet, 7 - 8 mm long.

The species extends from New Brunswick on the north to east Texas on the south (Fernald, 1951) and is generally distributed throughout Virginia in damp woods (Fig. 1), less commonly in disturbed areas and is rarely associated with limestone. In addition to material examined in this study (Fig. 1) is reported from Giles County (Thorne and Cooperrider, 1960), Washington County (Jervis, 1969), Lee County (Carr, 1965) and from Accomack, Arlington, Amelia, Charles City, Northampton, Scott, Wythe Counties and the City of Virginia Beach. It is in flower and fruit from mid-June to late August (-late September).

Fernald (1950) reports var. *confertifolia* L. with gray puberulent leaves and simple margin teeth from eastern Virginia. The variety is not recognized in this study as the characters are not reliable; there are simple and double teeth on the same plant (*Lewis, 1022,* VPI).

FIG. 1—Distribution of *Phryma leptostachya* in Virginia. Dots indicate exact locations, squares indicate literature citations and open circles indicate a specimen seen without specific location data.

Plantaginaceae

1. *Plantago* L. Plantain.

Annual or perennial herbs. Leaves basal or opposite on branched stems. Spike scapose or axillary. Flowers hypogynous, actinomorphic, 4-merous; sepals united basally, petals united, the lobes erect, spreading or reflexed, membranous, persistent; stamens long exserted or not, anthers versatile; stigmas 2-cleft; capsule circumscissle, bilocular, 2 to many seeds.

Key to Species

A. Caulescent, leaves linear, opposite, spike axillary .... 9. *P. psyllium*.
AA. Acaulescent, leaves lanceolate to ovate, in basal rosettes, spike scapose .... B.
  B. Bracts subtending flowers (0.6-) 1 - 4 (-6) cm long, conspicuous; a taproot ....
                                 5. *P. aristata*.
  BB. Bracts subtending flowers shorter, inconspicuous; fibrous roots or a taproot ....C.
    C. Leaves ovate to elliptic, the largest 5 - 22 (-39) cm long, 2.5 - 8.5 (-10.5) cm wide, roots fibrous...................... D.
      D. Lateral veins branching from mid-vein within tissue of blade, fibrous roots conspicuously thickened, aquatic or semi-aquatic habitat .... 1. *P. cordata*.
      DD. Lateral veins arising at base of blade from within petiole, fibrous roots slender, terrestrial habitats .... E.
        E. Largest leaves (8.5-) 10.5 - 25 (-39) cm long, 3 - 9 (-11.2) cm wide, petioles purple to red at base, fruit circumscissle near base .... 3. *P. rugelii*.
        EE. Largest leaves (5-) 8 - 14 (-22.5) cm long, 2.5 - 5.6 (-8.3) cm wide, petioles green at base; fruit circumscissle near middle .... 2. *P. major*.
    FF. Leaves linear to lanceolate to oblanceolate, generally shorter and more narrow than above.......................... F.
      F. Leaves linear, 1 - 2.5 mm wide, remotely toothed; 10 - 25 seeds per capsule; spikes loosely flowered .... 7. *P. heterophylla*.
      FF. Leaves wider, entire or rarely toothed; 2 seeds per capsule; spikes densely flowered .... G.
        G. Plants pubescent, leaves oblanceolate to elliptic; corolla lobes erect, forming a beak after flowering ..... 6. *P. virginica*.
        GG. Plants glabrous to downy, leaves linear-lanceolate to narrowly elliptic to lanceolate; corolla lobes spreading to reflexed after flowering .... H.
        H. Leaves 5-veined, narrowly elliptic to lanceolate, (8.8-) 19.8 - 36 cm long, (3.3-) 4 - 31 (-65) mm wide, stamens long exserted, conspicuous; fibrous rooted .... 4. *P. lanceolata*.
        HH. Leaves 3-veined, linear-lanceolate, about 10 cm long, 5 mm wide, stamens not conspicuous; with a taproot .... 8. *P. wrightiana*.

1. *Plantago cordata* Lamarck

Acaulescent aquatic perennial with conspicuously thickened fibrous roots; leaves basal, broadly ovate to cordate-ovate, entire to remotely dentate, the largest (blade and petiole) 15.3 - 32 cm long, (3.5-) 7.5 - 10.5 cm wide, the lateral veins branching from the mid-vein within the leaf blade; spike 10 - 18 cm long, loosely flowered, scape 18 - 36 cm long; corolla lobes spreading after flowering, capsule circumscissle just below middle; 2 - 4 seeds. Chromosome number 2n = 24 (Bassett, 1967).

The species extends from eastern Ontario south through Michigan and Illinois to Alabama and Florida (Bassett, 1967) but *P. cordata* may be extirpated from the State as the most recent collection occurred in 1902. Known from three collections: Alexandria: 1887, *Comstock s.m.* (NY); on bar extending into Potomac River at Alexandria Light, Aug. 13, 1902 (buds, flowers), *Shull 217* (MO, NY); Smyth Co.: Ravine of the Holston, June 8, 1892 (fruits), *Britton, Britton and Vail s.n.* (NY).

Plantago cordata is distinguished by the combination of veins branching from the mid-vein, the conspicuously fleshy roots and the semi-aquatic habitat.

Fig. 2
P. major

FIG. 2—Distribution of *Plantago major* in Virginia. Dots indicate exact locations, squares indicate literature citations, and open circles indicate a specimen seen without specific location data.

2. *Plantago major* L. Broad Leaf Plantain.

Acaulescent fibrous rooted perennial; leaves ovate to elliptic, the largest 4.8 - 22.5 cm long, (1.8-) 2.5 - 8.3 cm wide, entire to coarsely crenate, petioles green at base; scape 6 - 18 cm long; spike (7.5-) 9 - 19 cm long, remotely flowered below to densely so above; corolla lobes reflexed after flowering; capsule circumscissle near middle; 6 - 30 seeds. Chromosome number n = 6 (Radford, et al., 1968); 2n = 12 (Löve, 1979).

Although *P. major* is a cosmopolitan weed, it is relatively uncommon in the state (Fig. 2) in fields and waste ground. In addition to those localities for which I have examined material (Fig. 2) it is reported from Giles County (Thorne and Cooperrider, 1960), and from Accomack, Charles City, Craig, Frederick, Giles, Henrico, James City, Montgomery, Northampton, Pulaski, Shenandoah, Smyth, Tazewell, and Wythe Counties and Virginia Beach (Massey, 1961). These specimens have not been seen in this study and I suggest that some of the Massey citations may indeed be

P. rugelii which is more common over the state.

Plantago major is in flower and fruit from early June through August. It is distinguished by the combination of large ovate leaves, green petioles and the fruit circumscissle near the middle.

3. *Plantago rugelii* Dcne.

Similar to *P. major* but generally larger and more robust.

Leaves (8.6-) 10.5 - 40 cm long, (3-) 4.8 - 9 cm wide, entire, remotely toothed or coarsely lobed, conspicuously red to purple at petiole base; scape 8 - 30 cm long; spike (6-) 8.3 - 22 (-36) cm long, remotely to more commonly densely flowered; corolla lobes reflexed after flowering; capsule circumscissle below the middle; 4 - 10 seeds. Chromosome number n = 12 (Radford, et al., 1968); 2n = 24 (Bassett and Crompton, 1968).

The species extends from Quebec to North Dakota and south (Fernald, 1950) and is general over the state along roadsides, in fields and woods, and more rarely along stream banks and in cultivated areas (Fig. 3). Jervis (1969) reports *P. rugelii* from Washington County, and Massey (1961) from Botetourt and Green Counties, but the vouchers for these citations have not been seen. It is in flower and fruit from July through mid-October.

Plantago rugelii is distinguished from *P. major,* which it closely resembles, by the combination of red petioles, the capsule circumscissle below the middle and the generally large size.
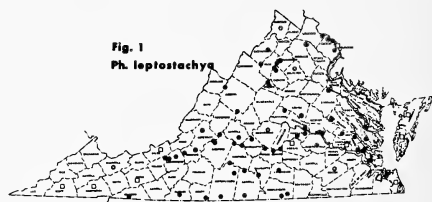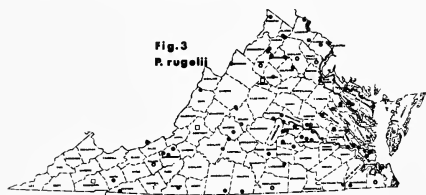
FIG. 3—Distribution of *Plantago rugelii* in Virginia. Dots indicate exact locations, squares indicate literature citations, and open circles indicate a specimen seen without specific location data.

4. *Plantago lanceolata* L. English Plantain; Buckhorn; Ripplegrass; Ribgrass.

Acaulescent perennial with fibrous roots; leaves narrowly elliptic to lanceolate, the longest (8.8-) 16 - 30 (-36) cm long, (0.3-) 0.9 - 3.7 (-6.5) cm wide, the 5 (-7) veins prominent; scape 17 - 65 cm long, slender; spike 2.8 - 5.2 (-6.9) cm long, slender, compact; stamens long exserted; corolla lobes spreading or reflexed after flowering; capsule circumscissle near the base; 2 seeds. Chromosome number n = 6 (Radford, et al., 1968); 2n = 12 (Bassett and Crompton, 1968; Löve, 1979).

A common European native in the eastern United States, it occurs generally throughout the state along roadsides, in yards, in fields, along railroads and in disturbed areas in general (Fig. 4) with the possible exception of the southwestern counties where it should be anticipated. It is in flower and fruit from mid-April to early October.

P. lanceolata is distinguished by the combination of prominently ribbed, lanceolate leaves and the compact spike borne on a long slender scape.
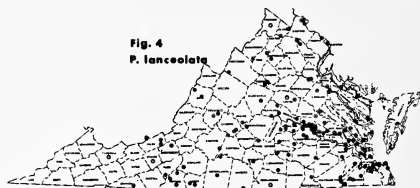
FIG. 4—Distribution of *Plantago lanceolata* in Virginia. Dots indicate exact locations, open circles indicate specimens seen without specific location data.

5. *Plantago aristata* Michx. Bracted Plantain.

Acaulescent, winter annual with a taproot; leaves filiform, linear to elliptic, the largest 12.5 - 15 cm long, 2 - 9 mm wide; scape (5-) 12 - 26 cm long; spike densely flowered, (0.2-) 2.8 - 15 cm long, bearing conspicuous linear to attenuate bracts (0.6-) 1 - 4 (-6) cm long; corolla spreading after flowering; capsule circumscissle near middle, seeds 2. Chromosome number n = 10 (Radford, et al., 1968); 2n = 20 (Bassett and Crompton, 1968).

This species is common over the eastern United States (Fernald, 1950) and general over the state (Fig. 5) in old fields, pastures, on roadsides and railroad ballast and dry sandy soil. It is reported from Scott County (Massey, 1961); this voucher has not been seen. It is in flower and fruit from late May to early September.

The conspicuous bracts of the spike distinguish *P. aristata* in the genus. The taxon is extremely plastic; depauperate plants are found in sterile soil and fertile soil supports more robust growth.

FIG. 5—Distribution of *Plantago aristata* in Virginia. Dots indicate exact locations, squares indicate literature citations and open circles indicate a specimen seen without specific location data.

6. *Plantago viriginica* L. Dwarf Plantain; Hoary or Pale Seeded Plantain.

White pubescent, acaulescent winter annual with taproot; leaves oblanceolate to elliptic, the largest (2.3-) 4.5 - 9.5 (-12) cm long, 0.8 - 2.8 (-3.4) cm wide, entire to remotely toothed; scape (2.5-) 5 - 20 (-23) cm long; spike densely flowered, at least above, (1.8-) 4 - 14 (-21) cm long; corolla erect and forming a tawny beak over the capsule after flowering; capsule circumscissle near middle, 2 seeds. Chromosome number n = 12 (Radford, et al., 1968); 2n = 24 (Bassett and Crompton, 1968).

Relatively common over the continental United States (Fernald, 1950) and general throughout the state (Fig. 6) in fields, along roadsides and railroads, and in disturbed soil. It is reported from Amelia, Campbell, Scott, Shenandoah and Smyth Counties (Massey, 1961) but these vouchers have not been seen in the study. It is in flower and fruit from late March to early July and sporadically to early September.

Plantago virginica is distinguished by the white pubescent leaves and scapes and the conspicuous corolla beak over the mature capsule.
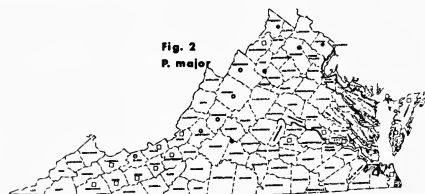

Fig. 6—Distribution of *Plantago virginica* in Virginia. Dots indicate exact locations, squares indicate literature citations and open circles indicate a specimen seen without specific location data.

7. *Plantago heterophylla* Nutt.

Acaulescent, taprooted winter annual; leaves linear, the longest 3.5 - 4 (-5.5) cm long, 1 - 2.5 mm wide, entire to remotely toothed; scape (4.0-) 6.2 - 10.2 (-11.5) cm long; spike 2.2 - 5.1 cm long, the axis visible for most of the length in fruit; corolla lobes connivent around capsule after flowering; capsule circumscissle below the middle, 12 - 25 seeds. Chromosome number n = 11 (Radford, et al., 1968); 2n = 12 (Bassett, 1966).

The species extends from Florida to California and north to Missouri, Illinois and Kentucky (Fernald, 1950) and southwestern Virginia (Fig. 7) in fallow and cultivated fields and in weedy areas. It is reported in Southampton County (Massey, 1961). It is in flower and fruit from mid-April through May

Plantago heterophylla is distinguished by the linear leaves, loosely flowered spike and relatively small size of the plant.

Fig. 7—Distribution of *Plantago heterophylla* in Virginia. Dots indicate exact locations and the square indicates a specimen cited in the literature.

8. *Plantago wrightiana* Dcne.

Acaulescent, annual or winter annual with taproot; leaves linear to narrowly lanceolate, ca. 2X as long as wide; scapes stout, to 20 cm long, minutely pubescent; spikes densely flowered, to 5 cm long, the bracts broadly lanceolate to deltoid, the margin scarious about half the area of the bract; flowers perfect; corolla reflexed after flowering; capsule ca. 5 mm long, circumscissle near middle; seeds 2, ca. 3 mm long, olive brown (based on Kearney and Pebbles, 1951). Chromosome number 2n = 20 (Bassett and Crompton, 1968).

Plantago wrightiana, indigenous to North Aermica, ranges from South Carolina and Georgia west to Texas and Arizona (Bassett and Crompton, 1968) and is reported here initially as an element of the flora of Virginia: Mechlenburg County: Seaboard Railroad track near Lake Gaston, June 24, 1967 (fl, fr), *Seaman 7099 (UNC)*.

This species is distinguished by the narrow leaves, large capsules and lanceolate to deltoid bracts.
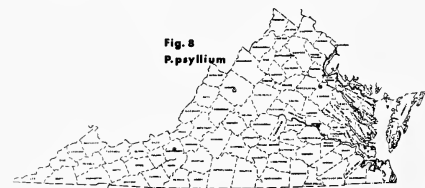
Fig. 8—Distribution of *Plantago psyllium* in Virginia. Dots indicate exact locations and the open circle indicates a specimen seen without specific location data.

9. *Plantago psyllium* L. Psyllium.

Caulescent, branched annual 1.8 - 4 dm tall, taprooted; leaves opposite, linear, 8 - 13 mm long, 3 - 4.5 mm wide, firm; spikes axillary, compact, 8 - 13 mm long; corolla reflexed after flowering; capsule circumscissle near base, seeds 2. Chromosome number 2n = 12 (Bassett and Crompton, 1968).

P. psyllium is scattered over the eastern United States and adjacent Canada from Quebec to Minne-

sota and south to Illinois, Indiana, Ohio and Virginia (Fernald, 1950). It is rare in the State, known from four counties (Fig. 8) where it occurs in railroad ballast and on the VPI & SU campus. It is in flower and fruit from late June through August.

Plantago psyllium is distinguished by its caulescent and branched habit.

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Distribution and Composition of the Macrophyte Community in Mountain Lake, Virginia

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Abstract—The distribution and composition of a macrophyte community in a montane, oligotrophic lake is described. *Nitella flexilis* (L.) Ag was the dominant species and its distribution was based on substrate characteristics and degree of basin slope. This species was most common in sediment with a high organic content and grew best on moderate/gentle slopes. A morphologically similar species, *Chara braunii,* was prevalent in shallow areas and was common particularly in those areas that have been enriched by sand. The presence of both species represents new published state records for Virginia.

Introduction

Mountain Lake, located at an elevation of 1180 m on top of Salt Pond Mountain near Pembroke, Virginia, occupies one of two natural lake basins in Virginia. The basin is oriented in general north-south direction and is 870 m long by 255 m wide (Figure 1) (Roth and Neff, 1964). The Mountain Lake Hotel maintains a swimming area and boat dock at the lake's south end for hotel guests.

Several limnological studies have been made of this montane oligotrophic lake (Hutchinson and Pickford, 1932; Coker and Hayes, 1940; Roth and Neff, 1964; Marland, 1967; Obeng-Asamoa and Parker, 1972; Simmons and Neff, 1973; Parker, Wolfe and Howard, 1975; and Simmons, 1975). Most of these studies concentrated on the lake's physical-chemical properties, history, or productivity of the limnetic phytoplankton community. Dubay and Simmons (1979) studied the macrophyte community's relationship to the lake's strong metalimnetic oxygen maximum. In the course of describing the standing crop and biomass distribution within the lake basin, a very comprehensive list of macrophytes known to exist within the lake was also compiled.
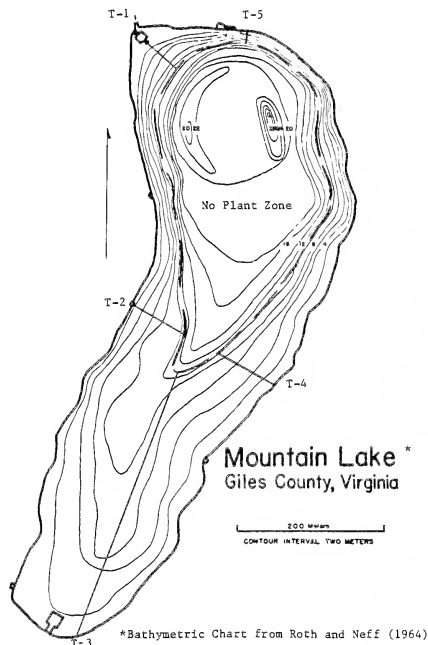
Fig. 1—Bathymetric map of Mountain Lake with transect positions.
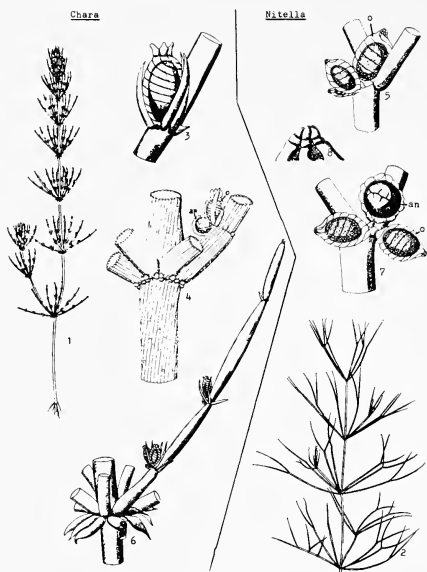
Fig. 2—Taxonomic characteristic of *Chara* and *Nitella* (Reproduced from Wood, 1967 by permission of Mrs. R. D. Wood).

The Problem

One of the lake's most interesting properties is the extensive and dense beds of rooted macrophytes which exist in the littoral zone. Even though Forest (1954), Roth and Neff (1964) and Obeng-Asamoa (1971) listed *Nitella flexilis* as the dominant macrophyte, there has been some controversy between biologists who have studied the lake (unpublished) over which macrophyte, *Chara braunii* or *Nitella flexilis,* was most abundant in the lake, or, in fact, if there were only one species. Both belong to the family Characeae and exhibit similar growth forms. For example, *C. braunii* Gm. (Fig. 2, No. 3), like *N. Flexilis* (L.) Ag. (Fig. 2, No. 5), lacks the extra layer of "cortex" cells (Fig. 2, No. 4) which cover the "stem" and "branchlets" of all other North American species of *Chara*. However, in *Chara* the "branchlets" are simple (Fig. 2, No. 1) while *Nitella* branchlets are further subdivided (Fig. 2, No. 2). *Chara* is further characteriezed by the presence of stipule-like structures (stipulodes) which hang down from each node (Fig. 2, No. 6). These structures are lacking in *Nitella* (Fig. 2, No. 5). The oogonia in *Chara* are crowned with a single tier of five coronula cells (Fig. 2, No. 3) while the corresponding structures of *Nitella* possess a double tier composed of ten coronula cells (Fig. 2, No. 8). In certain cases where *N. Flexilis*

(L.) Ag., which is usually monoecious (Fig. 2, No. 7), occurs in a dioecious condition (Fig. 2, No. 5), it can further be distinguished from *C. braunii* Gm. in which all reproductive specimens are monoecious (Wood, 1967).

We present here the results of our study on the species and biomass distribution pattern for the macrophyte community in Mountain Lake.

Methods and Materials

Benthic macrophytes were quantitatively collected along five underwater transects (N, S, E, and W, Fig. 1) during July and August 1973. The samples were collected by divers using SCUBA and a hand-operated 15.2 × 15.2 cm Ekman dredge. This procedure eliminated mechanical sampling error and ensured the removal of samples from precise depths. Each transect was sampled at the surface and 1-m depth intervals to 11 m, beyond which no macrophytes occurred. Five replicate samples were obtained from each depth on each transect for a total of 300 samples. Replicate samples at a given depth were separated by distances of approximately 1 m. Transect I was used for a pilot study.

Each sample was placed in labeled plastic bags in the field. In the laboratory, the plant material was separated from the soil by washing in a no. 35 mesh sieve (500 u mesh openings). Samples were then preserved by freezing and washed at a later time following the procedure described by Westlake (1969). All samples were examined under a stereomicroscope for extraneous material and then rinsed in 0.12 N HCl to remove any possible adhering carbonate. The samples were then dried (105 C for 24 hr) and ashed (500 C for 5 hr) according to methods of Westlake (1969) and American Public Health Association *et al.* (1971), respectively. Data are reported as ash-free dry weights/m^2.

Light penetration was measured with a Whitney photometer (model No. LMD8A-Motedore Corporation). The per cent grade of each transect slope was determined from the planimetric map of Roth and Neff (1964). Substrate composition was evaluated by visual observation.

Results and Discussion

We found 39 macrophyte species distributed through 22 families (Appendix 1). Most species were very low in numbers and restricted to only a few locations in very shallow water. Only five species were collected by dredge along the transects: (1) *Fontinalis novae-angliae* Sull., (2) *Chara braunni* Gm., (3) *Anacharis canadensis* (Michx.) Rich., (4) *Ceratophyllum demersum* L., and (5) *Nitella flexilis* (L.) Ag. In an oligotrophic Michigan lake, Rich, Wetzel and Thuy (1971) found 23 species (3 charophytes, no bryophytes, and 20 vascular plants) distributed through nine families.

Table I. - Mean ash-free dry weights (gms m^{-2}) for the dominant summer macrophyte species at each meter depth on all transects of the littoral zone and the total sample weight of each macrophyte in Mountain Lake, Virginia--July, 1973.

Depth (m)	Fontinalis novae-angliae Sull.	Chara braunii Gm.	Anacharis canadensis (Michx.) Rich.	Ceratophyllum demersum L.	Nitella flexilis (L.) Ag.	X̄ combined macrophyte weight (gm m^{-2})
0	73.83	.66	.03	0	.02	14.91
1	15.37	.94	.04	0	17.95	6.86
2	.17	0	.44	0	30.66	6.25
3	0	0	3.10	0	40.15	8.64
4	0	0	9.57	21.55	54.61	17.15
5	0	0	3.21	0	145.02	29.65
6	0	0	2.30	0	356.20	71.70
7	0	0	0	0	177.67	35.54
8	0	0	0	0	130.87	26.17
9	0	0	0	0	148.04	29.61
10	.01	0	0	0	76.07	15.22
11	0	0	0	0	.14	.03
Total*	89.38	1.60	18.74	21.55	1177.40	

*Total reflects the total sample weight of each macrophyte species.

Table II - Percent of sample ash-free dry weight occupied by each of the 5 rooted macrophytes collected from 5 transects combined in Mountain Lake, Virginia--July, 1973.

Depth (m)	Fontinalis novae-angliae Sull.	Chara braunii Gm.	Anacharis canadensis (Michx.) Rich.	Ceratophyllum demersum L.	Nitella flexilis (L.) Ag.
0	99.05	.89	.03	0	.03
1	44.82	2.47	.12	0	52.32
2	.54	0	1.42	0	98.04
3	0	0	7.15	0	92.85
4	0	0	11.16	25.14	63.70
5	0	0	2.16	0	97.84
6	0	0	.64	0	99.36
7	0	0	0	0	100.00
8	0	0	0	0	100.00
9	0	0	0	0	100.00
10	.02	0	0	0	99.98
11	0	0	0	0	100.00
Total	6.83	.12	1.43	1.65	89.97

Frantz and Cordone (1967) found 19 species (2 charophytes, 4 filamentous algae, 13 bryophytes, and no vascular plants) distributed through eight families in ultra-oligotrophic Lake Tahoe. Wilson (1937) found only 27 species of vascular plants distributed through 18 families in a eutrophic Wisconsin lake. It is not uncommon to find the macrophyte community to be both rich in species numbers and biomass in oligotrophic lakes. Such plants are intimately associated with sediment from which they can obtain necessary nutrients (Pearsall, 1920; Wetzel, 1975) and the clear water allows deep-water growth to the compensation point. Pressure at depth is often limiting for higher plant species, which possess gas-filled lacunae, but not for lower macrophytes, such as bryophytes or charophytes (Hutchinson, 1975).

The mean biomass distribution of the five dominant species with depth is presented in Table I. The dominant macrophyte in Mountain Lake is *N. flexilis* and

comprised almost 90% of the lake's standing crop (Table II). According to Choudhary and Wood (1973), *N. Flexilis* has not previously been reported for the State of Virginia. *Nitella's* toleration for reduced light levels (Daily, 1959) and fine silted substrate (Daily, 1959; Pearsall, 1920) allow it to grow well in Mountain Lake's littoral zone. The maximum biomass of this species occurred below four meters where it comprised approximately 99% of the standing crop (Table II). Although *Nitella* is reported to survive at low light intensities 0.3% of surface light (Frantz and Cordone, 1967), we found its growth to stop at 11 meters which closely corresponded to 1% of surface light levels (Fig. 3). The distribution pattern of this species around the lake indicated that it grew best on the north facing slope which had the most gradual slope (Fig. 1; Table III). Moreover, *Nitella* did not grow well in areas where there was a reduction of organic content in the sediment.

Table III.- Combined standing crop ash-free dry weights (gms m^{-2}) and total ash-free dry weight of the rooted macrophytes on each of 5 transects in Mountain Lake, Virginia--July, 1973.

Depth (m)	Transect 1 (East-facing)	Transect 2 (East-facing)	Transect 3 (North-Facing)	Transect 4 (West-facing)	Transect 5 (South-facing)	X̄ combined macrophyte weight (gm m^{-2})
0	.01	27.75	45.90	.81	.07	14.91
1	3.50	14.95	15.86	0	0	6.86
2	.14	6.43	20.69	1.29	2.73	6.25
3	6.96	9.16	14.41	10.73	1.93	8.64
4	15.14	15.81	46.51	6.96	1.30	17.15
5	22.36	39.63	22.57	47.96	15.71	29.65
6	44.23	73.66	183.70	42.91	14.00	71.70
7	25.58	33.20	27.29	32.48	59.12	35.54
8	47.70	27.10	18.58	30.29	7.20	26.17
9	25.17	65.85	13.37	18.79	24.86	29.61
10	21.29	46.32	3.55	2.56	2.36	15.22
11	0	.002	0	0	.13	.03
Total*	212.08	359.86	412.43	194.78	129.41	
% Grade	13.8	13.8	2.9	12.4	61.0	

*Total reflects the total plant weight for each transect.
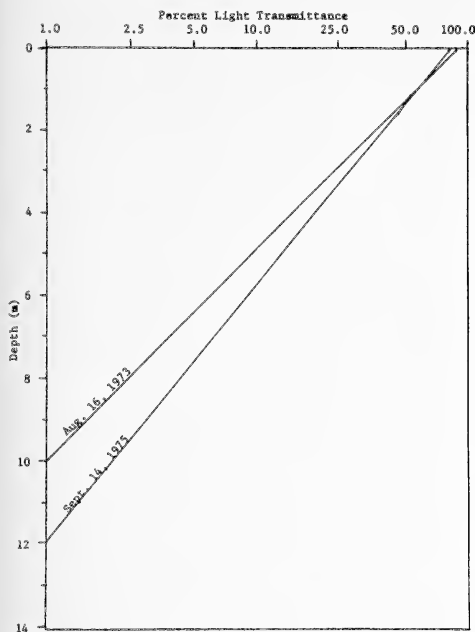
FIG. 3—Unfiltered light transmission at noon in Mountain Lake, Virginia.

Chara braunii was sparsely represented and restricted to the shallow southern end of the lake (Tables I and II). The limited distribution of this species appears to be due to its requirement for a quartz sand substrate (Shen, 1971) with low organic content (Proctor, 1967). The sandy beach area around the boat dock would meet both requirements. The presence of *C. braunii* also appears to represent another new state record for Virginia (Choudhary and Wood, 1973).

Anacharis canadensis was distributed around the lake's basin to a depth of six meters. The fact that it does not grow deeper is not surprising since Hutchinson (1975) reported that such higher macrophytes with lacunae are often depth limited by pressure. *Ceratophyllum demersum* was found only along Transect 3 at four meters. Our inability to relocate this population two years after the initial study may indicate that these plants are unattached and drift near the substrate as reported by Hutchinson (1975). The bryophyte, *F. novae-angliae,* was found only below 2 m usually growing on rocks and logs. This bryophyte has been recorded from depths of 13-20 m in certain clear Wisconsin lakes (Juday, 1934) where the water was oligotrophic (secci = 13 m).

Summary

The macrophyte community of Mountain Lake is very rich in both the number of families and species represented. Two new state records have been determined and our study showed that *N. flexilis* is the dominant macrophyte in the lake. *Chara braunii* occurs in the lake, but is limited to the very shallow sandy area immediately to the west of the boat house at the lake's south end. Since this is the end frequented by hotel guests and scientists alike, and the area is enriched by sand additions for swimming purposes, it is easy to understand why it could previously have been construed that *C. braunii* was the lake's dominant littoral species. *C. braunii*, however, is not as well adapted as *N. flexilis* for the substrate conditions that prevail in Mountain Lake. *Nitella flexilis* concomitantly is absent from the shallow areas where it would be easily missed by collectors wading near shore.

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Appendix I.—List of macrophytes growing in Mountain Lake, Giles County, Virginia, 1973-1975.

I. ALGAE: (Nomenclature according to Wood, 1967)
   CHARACEAE: *Chara braunii* Gm., *Nitella flexilis* (L.) Ag.
II. BRYOPHYTES: (Nomenclature according to Conard, 1956)
   A. Mosses (Musci):
      FISSIDENTACEAE: *Fissidens bryoides* Hedw.; *Fissidens hallianus* (Sull. and Lesq.) Mitt.
      MNIACEAE: *Mnium punctatum* Hedw.
      HYPNACEAE: *Brachythecium rivulare* B. S. G.; *Climacium americanum* Brid.; *C. Kindbergii* (Ren. & Card.) Grout; *Hygrohypnum eugyrium* (B. S. G.) Loeske; *Leptodictyum riparium* (Hedw.) Warnst
      FONTINALACEAE: *Fontinalis novae-angliae* Sull.
   B. Liverworts (Hepaticae):
      HARPANTHACEAE: *Chiloscyphus pallescens* (Ehrh.) Dum.
      PLAGIOCHILACEAE: *Plagiochila asplenioides* (L.) Dum.
      SCAPANIACEAE: *Scapania undulata* (L.) Dum.
      PORELLACEAE: *Porella pinnata* L.
      RICCARDIACEAE: *Riccardia latifrons* Lindb.
III. VASCULAR PLANTS: (Nomenclature according to Gleason and Cronquist, 1963)
      EQUISETACEAE: *Equisetum arvense* L.
      ISOETACEAE: *Isoetes engelmannii* A. Br.
      POTOMOGENTONACEAE: *Potomogeton spirillus* Tuckerm.
      ALISMATACEAE: *Alisma plantago-aquatico* L.
      HYDROCHARITACEAE: *Anacharis canadensis* Michx.; *A. nuttallii* (Planeh.) St. John
      CYPERACEAE: *Carex baileyi* Britt.; *C. crinita* Lam.; *C. frankii* Kunth; *C. scoparia* Schk.; *Eleocharis obtusa* (Willd.) Schultes; *E. palustris* (L.) R. & S.
      JUNCACEAE: *Juncus acuminatus* Michx.; *J. brevicaudatus* (Engelm.) Fern. *J. bufonius* L.; *J. effusus* L.; *J. marginatus* Rostk.; *J. tenuis* Willd.
      SALICACEAE: *Salix sericea* Marsh.
      POLYGONACEAE: *Polygonum scandens* L.
      CERATOPHYLLACEAE: *Ceratophyllum demersum* L.
      CALLITRICHACEAE: *Callitriche heterophylla* Pursh.
      HYPERICACEAE: *Hypericum mutilum* L.

Vascular Flora and Vegetation of the Kent Branch Watershed, Fluvanna County, Virginia[1]

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Abstract—The Kent Branch Watershed is a fourteen square mile area located in north-central Fluvanna County, Virginia. This county is located in the central Piedmont of Virginia, north of the James River, about 30 miles east of the Blue Ridge Mountains. Collections of the vascular flora began in March of 1975 and continued until July of 1976. A total of 752 species were collected including 733 new to Fluvanna County.

Major plant communities of the area were studied both qualitatively and, where applicable, quantitatively using the Bitterlich method of forest sampling.

Introduction

The Kent Branch Watershed comprises approximately 14 square miles of rolling terrain in the central Piedmont of Virginia. The area essentially includes the whole watershed of Kent Branch to its confluence with Venable Creek to form Byrd Creek, a tributary of the James River.

There are many mountain-Coastal Plain disjuncts in Virginia and more work in the Piedmont is needed to clarify whether at least some of these are collecting artifacts. The reason for this is that much more extensive collecting has been done in the mountains and on the Coastal Plain than in the intervening Piedmont. Botanical work has been done in the southern Piedmont by Hathaway, Harvill, Ramsey, Stevens, and others, and floristic work has also been carried out in the northern Piedmont by such botanists as Allard, Bradley, Leonard, and Mazzeo, but there exists a serious need for comprehensive floristic studies of Piedmont counties. Thus the Piedmont location was the first consideration in the selection of the study area, and a Fluvanna County (Figure 1) locality was then chosen because of the specific need for floristic work in that county. No extensive botanical work has been done in Fluvanna County prior to this study, although limited collecting has been done from time to time in Fluvanna by Virginia botanists such as Charles E. Stevens and Thomas F. Wieboldt. Published records of the flora of Fluvanna County are rare.

Methods

Collection of specimens of the vascular flora of the Kent Branch Watershed began in March 1975 and continued through July 1976. Collecting trips were taken on an average of once weekly during the growing season. Habitat and abundance data for each taxon are based on collection data and personal observation.

| Valley and Allegheny | Blue Ridge | Piedmont | Coastal Plain |
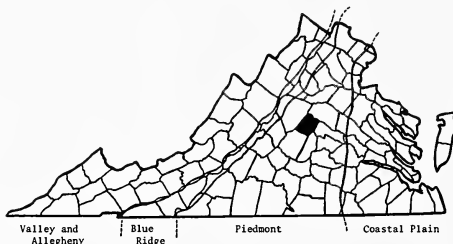
FIG. 1—Location of Fluvanna County in the Piedmont of Virginia.

Nomenclature for specific and subspecific taxa follows that of Radford, Ahles, and Bell (1968).

Determination of county, northern Piedmont (north of the James River), and Piedmont distributional records is based on the works of Allard and Leonard (1943, 1944, 1952, 1962), Bradley (1972, 1973), Gilman (1957), Grimshaw and Bradley (1973), Harvill (1973b), Hathaway and Ramsey (1973), Johnson (1970, 1971a, 1971b, 1972a, 1972b, 1974a, 1974b, 1974c), Lewis (1958), Massey (1961), Mazzeo (1972), Nessler (1976), Ramsey (1967), Ramsey et al. (1969), Roane (1975), Roe (1977), Smith (1976), and Thacker et al. (1968).

A vegetational study of the area was conducted, and quantitative data obtained for a number of diverse forest stands. Stands were subjectively selected for quantitative sampling as being representative of important community types in the study area. Dominance was measured (in square meters per hectare, cross-sectional area breast high) by the Bitterlich method (Beers and Miller 1964), using a Spiegel Relaskop (angle gauge). Relative dominance for each

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Footnotes

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species was calculated by dividing the measured domi-
nance for that species by the sum of the dominance for
all species in the stand. The density of each species (in
trees per hectare) was based on counts of stems with a
diameter at breast height of four inches or greater
found in circular plots with a radius of ten meters (32.8
feet). Relative density was determined as was relative
dominance and an average of these two values was
taken as the relative importance value (I.V.).

Soil samples (Table 1), taken at random from all of
the forest stands measured, were obtained on May 20,
22, and 23, 1976. Samples were taken from several
points in each stand, combined, and analyzed for Ca,
Mg, K, pH, and salt concentration by the Virginia
Truck and Ornamentals Research Station, Norfolk,
Virginia.

TABLE 1.   Results of Soil Analysis[a].

Stand	pH	Calcium[b]	Magnesium[b]	Potash[b]	Salt Conc.[c]
1	4.7	1098	416	227	64
2	4.5	d	292	493	69
3	4.0	d	52	265	69
4	4.6	d	132	137	64
5	4.6	d	120	115	62
6	4.8	1188	416	300	60
7	4.6	1188	416	161	58
8	4.6	336	488	3158	107

[a]Analysis by Virginia Truck and Ornamentals Research Station, Norfolk.

[b]In lbs. oxide/acre

[c]In parts per million

[d]Not determined

Geology

Fluvanna County is situated on the southeastern
limb of the Blue Ridge Anticlinorium and is located
entirely within the Piedmont physiographic province
(Smith et al. 1964). The surface features are in general
those of a moderately high plateau dissected by
numerous streams (Porter 1958). The total relief of the
study area, located in north-central Fluvanna County,
is 270 feet, ranging from a high of 530 feet near the
Fluvanna-Louisa County line in the north to a low of
260 feet along Kent Branch at the southern tip of the
watershed (U.S. Geological Survey 1970). The drain-
age pattern of the Kent Branch Watershed, like most
others in Fluvanna, is dendritic. This reflects the
homogeneity of the parent material in its response to
weathering. Since the area has a generally warm and
moist climate, chemical weathering is very active. A
deep layer of rock residuum has developed over almost
all uplands in the area and this indicates extensive
weathering (Smith et al. 1964).

The underlying rocks of the country range from the
Cambrian or Precambrian Catoctin Formation
through the Upper Ordovician Arvonia Formation.
The sequence is largely faulted and folded volcanic and
sedimentary rocks that have undergone low to medium
grade metamorphism and have been intruded by Tri-
assic diabase dikes. One important formation exposed
in northeastern Fluvanna is a metamorphosed vol-
canic and sedimentary rock unit of Ordovician age.
This unit is composed primarily of gneiss, schist, phyl-
lite, and quartz-feldspar rocks. Another formation
exposed in the study area is a medium to coarse-
grained granidiorite unit probably intruded around
400 million years ago (Smith et al. 1964).

The parent materials present have weathered into a
variety of soil types depending on such factors as slope
and age. In many areas of the county, sheet erosion has
been so severe that significant areas of land surface
have been stripped of soil layers, sometimes down to
the parent material (Porter et al. 1958).

Among the important soil series found in Fluvanna
County are the Tatum and Nason series on the
uplands, the Manteo series in areas of steep relief, and
the Congaree and Mixed Alluvial series on bottom-
lands (Porter et al. 19658). Soil differentiation is
dependent to a certain extent on factors such as mois-
ture and slope, and these conditions, along with min-
eral availability and pH, control the presence of cer-
tain plant associations. An example is seen on the
bluffs along Kent Branch. Here the moisture and eda-
phic conditions favor the existence of a characteristic
plant association including *Polypodium virginianum,
Thalictrum thalictroides, Hepatica americana, Cim-
icifuga racemosa,* and *Arabis canadensis.*

The type of climax community present in a given
area also seems to be partially determined by the soil
series and other edaphic factors present. A good
example is the greater structural importance of *Quer-
cus prinus* on rocky soils and on soil series character-
ized by excessive drainage. This is further discussed in
the section dealing with vegetational patterns.

Climate

Due to its location in the central Virginia Piedmont,
the climate of Fluvanna County is continental. Tempera-
tures and rainfall are relatively uniform throughout
the county because of the lack of modification by large
bodies of water or mountains. The average growing
season is 186 days, extending from April 17 (average
date of last killing frost) to October 20 (average date of
first killing frost). The average annual temperature is
56.3°F (Porter et al. 1958).

Rainall, as a general rule, is evenly distributed
throughout the year with slightly more in the spring
and summer. The average annual rainfall in Fluvanna
County is 44.24 inches (Porter et al. 1958).

Past climatological conditions may have played an
important role in determining the floristic composition

of many Piedmont communities. According to Harvill (1973a), the xerothermic period of post-glacial times may have significantly affected the Piedmont vegetation. Many species probably survived this period of stress only in special edaphic and hydrologic situations. The lack of such situations, including bogs, sandy areas, and limestone-derived soils in the Piedmont, is significant in this respect. This could possibly explain both the present absence of many plants from apparently suitable habitats and the many interesting disjunctions and other distributional problems now seen in the flora of Virginia (Harvill 1973a).

Vegetational Patterns

As would be expected in a study area of this size (fourteen square miles), there is a great deal of vegetational diversity in the Kent Branch Watershed. The major plant communities present include: 1) upland woods—subdivided into deciduous woods, mixed pine-deciduous woods, and pine woods 2) bottomland woods 3) freshwater lakes and marshes 4) early old field successional areas and 5) recently disturbed areas. Each of these major community types can be broken down into subdivisions that are very different from both structural and functional standpoints.

Table 2. Total Dominance, Total Density, and Species Importance Values for the species in each stand.

| Tree Species | Stand Number[a] | | | | | | | |
	1	2	3	4	5	6	7	8
Acer rubrum	9.47%	1.00%	12.28%	0.99%	6.50%		26.45%	26.50%
Betula nigra							7.96	
Carpinus caroliniana					1.07		20.66	27.44
Carya glabra		8.84	5.59	4.99				
Carya ovata		2.81						
Carya tomentosa	4.23	1.81	1.43	1.52				
Cornus florida				0.99	2.99		1.92	
Fraxinus americana	7.24							
Fraxinus pennsylvanica								5.78
Fraxinus ssp.					1.48		3.87	
Juniperus virginiana	8.81					6.44%		
Liquidambar styraciflua	6.46			8.48	8.73		7.45	17.94
Liriodendron tulipifera	1.45				2.88		9.37	3.00
Nyssa sylvatica	1.56	.81		0.99	1.82			
Pinus echinata	1.45			4.46	26.20	0.73		
Pinus virginiana					34.50	92.84		
Platanus occidentalis							7.72	5.40
Prunus serotina		1.00			5.43			
Quercus alba	28.96	51.39	31.13	39.27	5.86		3.87	2.40
Quercus bicolor								3.39
Quercus coccinea			22.88					
Quercus falcata	1.45			21.94	1.82		1.11	
Quercus lyrata							1.92	
Quercus marilandica				3.47				
Quercus palustris								3.39
Quercus phellos								2.40
Quercus prinus		26.46	13.15					
Quercus rubra	6.35	2.62					6.91	
Quercus stellata	1.45	1.62	3.25	10.43	0.75			
Quercus velutina	19.81	1.62	10.46	2.50				
Ulmus americana							0.81	2.40
Total Dominance (m^2/ha)	30.00	31.00	26.58	33.98	44.68	35.00	20.32	33.33
Total Density (# trees > 4 in.DBH/ha)	407.43	397.89	313.73	350.13	498.67	1098.15	238.72	381.96

[a] Stands 1 through 4 are upland hardwoods, 7 and 8 are bottomland hardwoods, and 5 and 6 are pine stands.

Upland Woods

The upland woods of the area can be divided into three major subdivisions on the basis of quantitative data: 1) deciduous woods 2) mixed pine-deciduous woods 3) pine woods.

Deciduous Woods

The deciduous woods of the study area have been classified as members of the oak-hickory forest in the Temperate Deciduous Forest Biome (Shelford 1963), and from the data obtained, most seem to fit this designation. The oak-hickory community type is represented by stands 1-4 (Table 2). It can be seen here that there is significant variation among the four stands sampled. *Quercus alba* is the leading dominant in all four stands, but in stand 1 the leading associate is *O. velutina,* in stand 4, *Q. falcata,* in stand 2, *Q. prinus,* and in stand 3, *Q. coccinea,* through *Q. prinus* plays an important structural role here also. The dominance of *Q. alba* in these stands agrees with the findings of Gemborys (1974) in another Piedmont Virginia locality, Prince Edward County, where *Q. alba* was found as the leading dominant more than any other species. Stands 2 and 3 are located on a rocky slope and dry uplands respectively, and these habitat differences could partially explain the greater structural importance of *Q. prinus* in these two stands. This is also in agreement with the findings of Gemborys (1974), who found *Q. prinus* to be most important in xeric upland or rocky sites. The soil of the deciduous woods represented by stand 1 has considerable amounts of calcium and magnesium (Table 1) and the importance of *Q. velutina* (I.V. = 19.82) in this rich, mesic woods seems to agree with the findings of Oosting (1942) in Piedmont (Durham County) North Carolina. Oosting found that *Q. alba- Q. velutina- Q. falcata* type forests occurred primarily on the better upland sites.

Common canopy associates in the deciduous woods sampled include *Carya glabra, C. ovata, C. tomentosa, Quercus rubra, Q. stellata, Q. marilandica, Liriodendron tulipifera, Liquidambar styraciflua, Nyssa sylvatica,* and *Fraxinus americana.* Understory species present include *Cornus florida, Carpinus caroliniana, Acer rubrum,* and *Chionanthus virginicus.*

The herb layer present varies greatly depending on a number of factors and provides an interesting aspect of community diversity. Stands 1 and 2 are most similar in terms of herbaceous cover, both having a much richer and more diverse herb layer than the other stands sampled. A possible explanation is that while the two stands differ a great deal in tree composition, both are located on slopes above streams. In terms of the herb layer supported, the very rocky substrate of stand 2 does not seem very different from stand 1 with its much deeper soil. Species found in both stands include *Stipa avenacea, Melica mutica, Oxalis stricta, Coreopsis auriculata,* and *Chrysogonum virginianum.* Other species found in one or the other of these stands include *Iris verna, Liparis lilifolia, Ranunculus hispi-*

dus, Silene stellata, Thaspium trifoliatum, Chimaphila umbellata, Pyrola rotundifolia, and *Erigeron pulchellus.* The herb layer of stands 3 and 4, almost depauperate in comparison with stands 1 and 2, includes such species as *Cypripedium acaule* and *Chimaphila maculata.*

A particularly interesting floristic association is located in deciduous woods on and above the old Adam's millrace, beside Kent Branch about one-half mile from its confluence with Venable Creek. The site was not sampled quantitatively due to evidence of selective timbering operations in the past. The area is quite limited in size, stretching approximately 100 yards along the millrace and the slopes above. One unusual aspect of the site is an extremely extensive and dense colony of *Adiantum pedatum* with a large amount of *Lycopodium lucidulum* beneath. Other species of interest include *Chamaelirium luteum, Amianthium muscaetoxicum, Aconitum uncinatum, Gillenia trifoliata, Aruncus dioicus, Obolaria virginica,* and *Phlox carolina.* The last seven of these species have been observed nowhere else in the study area, and the sloped, northfacing, very mesic habitat apparently satisfies certian ecological requirements. The lack of other suitable habitat seems to severely limit their distribution in other parts of the Kent Branch Watershed.

Mixed Pine-Deciduous Woods

This community type is the result of secondary successional processes and can be formed in several ways, including abandonment of old fields and clearcutting. There is a large amount of variation in the mixed pine-deciduous woods ranging from areas where *Pinus virginiana* predominates, such as stand 5 (Table 2), to those where deciduous trees predominate. Canopy species often found in this community type include *Pinus virginiana, P. echinata, Quercus* ssp., *Acer rubrum, Liquidambar styraciflua, Liriodendron tulipifera,* and *Nyssa sylvatica.* Understory trees include *Carpinus caroliniana* and *Cornus florida.* Herbaceous and shrub components of the community vary with the amount of canopy cover and other factors, but often include such species as *Rhus radicans, Chimaphila maculata, Euonymus americanus, Lonicera japonica,* and *Lycopodium flabelliforme.*

Pine Woods

There are large areas of pine woods in the Kent Branch Watershed. These are the result of both pine plantation operations and natural successional processes. During the period since World War II, large lumber companies, as well as private land owners, have planted extensive areas of land in *Pinus taeda.* Some of these plantations are quite extensive, occupying as much as a thousand acres. There is also one small plantation of *Pinus strobus* in the study area. The remainder of the pine woods in the area are the result of secondary succession, the process usually beginning with the abandonment of cultivated fields. Typical

pine woods in the Kent Branch Watershed are dominated by *Pinus virginiana* and *P. echinata.* Common associates in the shrub and herb layers include *Cypripedium acaule, Andropogon scoparius,* and *Vaccinium* spp.

Stand 6 is an example of a rather unusual pine woods. The canopy of this stand is dominated by *Pinus virginiana,* with an occasional *P. echinata.* There is a low understory of scattered *Juniperus virginiana,* and a shrub layer dominated by saplings of *Quercus* spp. with *Nyssa sylvatica* as an associate. Within this stand there are open areas with few pines, but with lichens covering a high percentage of the ground. An unusual floral association occurs in and around the open areas. Species of interest include *Corallorhiza odontorhiza, Muhlenbergia capillaris, Gymnopogon ambiguus, Sorghastrum nutans, Aristolochia serpentaria,* and *Liatris squarrosa.* This stand, located on rocky slopes above Kent Branch, seems to be second growth developing after cultivation, sheet erosion, and timbering. In certain respects, the area resembles pine barren habitats and explanations for this resemblance could include slope, rocky substrate, and progressive erosion.

Bottomland Woods

Bottomlands in the Kent Branch Watershed are mostly narrow floodplains along small streams. In many areas this habitat is under cultivation or in pasture. Other bottomlands, once used for agricultural purposes, have since been abandoned, resulting in the onset of secondary succession. This section deals with bottomlands which are wooded at the present time, stands 7 and 8 being examples. Stand 7 (Table 2) occupies a very wet area below an old millrace just off Kent Branch. There is some evidence of logging operations in the past, but quite some time has elapsed since the disturbance. *Acer rubrum* and *Carpinus caroliniana* are the dominants while other tree species of importance include *Liriodendron tulipifera, Betula nigra, Platanus occidentalis, Liquidambar styraciflua,* and *Quercus rubra.* The herbaceous layer includes *Glyceria striata, Carex* spp. and *Juncus* spp. There are differences in elevation of up to two feet in this stand, with tree species occupying the higher ground, and *Carex* spp. and other moisture tolerant species occupying the lower areas, which often have standing water.

Stand 8 (Table 2) is located in the floodplain of Kent Branch about one-half mile above its confluence with Venable Creek. This stand is frequently flooded and like the preceding one, has slight differences in elevation. Here also, trees occupy the higher ground with herbaceous species such as *Carex* spp., *Juncus* spp., and *Cardamine bulbosa* occupying the lower areas, which are often filled with standing water. Tree species of importance here include *Carpinus caroliniana, Acer rubrum, Liquidambar styraciflua, Fraxinus pennsylvanica, Plantanus occidentalis,* and *Quercus bicolor.* The structural importance of *Q. bicolor* is somewhat greater than that suggested by the data. Just outside the sampling area is a large grove of *Q. bicolor* and

both these and the individuals in the sampling area are the largest trees in this section of floodplain. The soil here differs significantly from that of all other stands studied. The site is in a poorly drained mixed alluvial area (Porter et al. 1958) and the high levels of potash and salt (Table 1) as well as other factors resulting from poor drainage, probably significantly influence the vegetation.

Freshwater Lakes and Marshes

Despite the fact that there are no natural bodies of standing water in the Kent Branch Watershed, there is a sizable amount of habitat present for aquatics, emergents and other plants that require or tolerate a great deal of moisture. In the past, such environments were provided by the numerous millponds that were situated on Kent Branch and its tributaries. This type of habitat is represented at the present by a large number of small man-made lakes and farm ponds, and also by a sizable number of beaver ponds.

Among the more interesting taxa found in wet habitats are *Erianthus giganteus, Xyris torta, Habenaria clavellata, Lysimachia nummularia,* and *Campanula aparinoides.*

Early Old Field Successional Areas

Although approximately 75 per cent of Fluvanna County is wooded (Porter et al. 1858), virtually none of the area is in mature forest. Most of the wooded portion is in various stages of secondary succession. Such areas have been treated in the sections on mixed pine-deciduous woods and pine woods. The present section deals with the successional sequence from the abandonment of cultivated fields to just after the closing of the canopy. There is a great deal of land undergoing such successional processes due to the increasing retirement of small farms as a result of economic pressures.

Early in the successional process, such taxa as *Andropogon virginicus, Seteria* spp., *Aster* spp., *Eupatorium* spp., and *Solidago* spp., predominate. As succession proceeds, such species as *Pinus virginiana, P. echinata,* and *Juniperus virginiana* become more and more important structurally. Upon closing of the canopy, the *Pinus* spp. and the *Juniperus virginiana* reduce light penetration to such an extent that the herb layer becomes almost nonexistent. Eventually, of course, shade-tolerant deciduous tree species will gain a foothold and ultimately come to dominance in most cases.

Recently Disturbed Areas

Included in this category are such habitats are roadsides, sawmills, and old homesites. A large number of species thrive under these conditions, a high percentage being of European nativity. Interesting species found in such habitats include *Artemisia ludoviciana* and *Eragrostis curvula.*

Distribution Records and Annotated Checklist of the Vascular Flora

A total of 752 species representing 402 genera of 111 families has been recorded from the Kent Branch Watershed. Of these, 733 are recorded for Fluvanna County, 87 are new to the Virginia Piedmont north of the James River, and 26 are Piedmont records. In the annotated checklist, those taxa that have previously been reported from Fluvanna Co., that is, are *not* county records, are preceded by an asterisk (*). Species not previously reported from the northern Piedmont are marked with a double asterisk (**), and Piedmont records are marked by a triple asterisk (***). Information on relative abundance in the study area is abbreviated as follows: A, abundant; LA, locally abundant; C, common, O, occasional; R, rare, SC, single colony or individual seen. Major habitat types have been abbreviated according to Table 3. Collecting numbers are those of the first author. The distributional information presented here was made available to Harvill, Stevens and Ware (1977) for inclusion in the Atlas of the Virginia Flora.

A complete set of voucher specimens has been deposited in the Herbarium of the College of William and Mary (WILL1) and duplicate specimens have been deposited in the Herbarium of the University of North Carolina at Chapel Hill (NCU). Nomenclature used in the annotated checklist follows Radford, Ahles, and Bell (1968).

Plants of particular interest include *Coreopsis auriculata,* the Fluvanna record being the northernmost record on the East Coast (Smith 1976), *Campanula aparinoides,* which has been found only twice previously south of Maryland east of the Appalachian Mountains, and *Eragrostis curvula* whose only other

Table 3. Key to Habitat Abbreviations

1.   Aquatic habitats

2.   Abandoned homesites (plants persisting or rarely escaping)

3.   Cultivated fields

4.   Roadsides, weedy areas, waste places, and disturbed sites

5.   Swampy areas

6.   Low wet fields and marshy areas

7.   Successional fields

8.   Forest margins

9.   Low wet woods

10. Rich mesic woods

11. Drier mixed deciduous woods

12. Rocky wooded slopes

13. Mixed pine-deciduous woods

14. Pine woods including cultivated pine plantations

Virginia station is Dinwiddie County.

During the course of this study, none of the classical Mountain-Coastal Plain disjuncts, including such taxa as *Helonias bullata, Magnolia tripetala,* and *Decodon verticillata* (Harvill 1965, 1972, 1973a), were found. In some cases, such an absence may be even more significant from a photogeographical viewpoint than the occurrence of the species. In this case, the absence of these taxa adds another piece of supporting evidence to the theory that these disjunctions are real, and not merely collecting artifacts due to a lack of knowledge concerning the Virginia Piedmont.

Annotated Checklist

PTERIDOPHYTA

   ASPIDIACEAE: <u>Athyrium asplenioides</u>, 9, A; 506. **<u>Dryopteris</u> <u>cristata</u>, 9, SC; 443. <u>D. intermedia</u>, 9, SC; 375. <u>D. marginalis</u>, 12, O; 781. <u>D. spinulosa</u>, 9, SC; 450. <u>Onoclea sensibilis</u>, 9, O; 788. <u>Polystichum acrostichoides</u>, 10, 11, 12, A; 767. <u>P. acrostichoides</u>, forma <u>incisum</u>, 14, SC; 1085. <u>Thelypteris hexagonoptera</u>, 10, O; 564. <u>T. noveboracensis</u>, 9, A; 465. <u>T. palustris</u>, 5, O; 907. <u>Woodsia obtusa</u>, 9, SC; 1075.

   ASPLENIACEAE: <u>Asplenium platyneuron</u>, 4, 12, 13, A; 5.

   BLECHNACEAE: <u>Woodwardia areolata</u>, 9, O; 846, 961-1.

   EQUISETACEAE: <u>Equisetum hyemale</u>, 9, O; 20, 1267.

   LYCOPODIACEAE: <u>Lycopodium flabelliforme</u>, 9, 14, A; 1153. <u>L. lucidulum</u>, 9, O; 1154. <u>L. obscurum</u>, 9, O; 1.

   OPHIOGLOSSACEAE: <u>Botrychium dissectum</u>, 11, C; 821, 638. <u>B. virginianum</u>, 11, C; 196. <u>Ophioglossum vulgatum</u> var. <u>pycnostichum</u>, 9, O; 1346.

   OSMUNDACEAE: <u>Osmunda cinnamomea</u>, 9, O; 479. <u>O. claytoniana</u>, 10, SC; 1590. <u>O. regalis</u>, 9, O; 599.

   POLYPODIACEAE: <u>Polypodium virginianum</u>, 12, R; 49.

   PTERIDACEAE: <u>Adiantum pedatum</u>, 10, LA; 445. <u>Dennstaedtia punctilobula</u>, 10, O; 596. <u>Pteridium aquilinum</u>, 4, 3, 13, C; 837.

   SELAGINELLACEAE: <u>Selaginella apoda</u>, 6, 9, C; 496.

CONIFEROPHYTA

   CUPRESSACEAE: *<u>Juniperus virginiana</u>, 4, 7, A; 1297.

   PINACEAE: *<u>Pinus echinata</u>, 13, 14, C; 1098. *<u>P. strobus</u>, 14, O; 1300. **<u>P. taeda</u>, 14, A; 1299. *<u>P. virginiana</u>, 7, 13, 14, A; 1286. *<u>Tsuga canadensis</u>, 9, SC; 1253.

ANTHOPHYTA

MONOCOTYLEDONEAE

   ALISMATACEAE: <u>Alisma subcordatum</u>, 5, 6, O; 610. <u>Sagittaria latifolia</u>, 1, SC; 1704-14.

   AMARYLLIDACEAE: <u>Hypoxis hirsuta</u> var. <u>hirsuta</u>, 10, 11, 13, A; 110. <u>Narcissus pseudo-narcissus</u>, 2, 9, C; 1236.

   ARACEAE: <u>Acorus calamus</u>, 5, SC; 343. <u>Arisaema dracontium</u>, 9, O; 541. <u>A. triphyllum</u>, 9, C; 117. <u>Symplocarpus foetidus</u>, 5, O; 377, 1191.

COMMELINACEAE: Commelina communis, 4, 9, C; 507, 483.

CYPERACEAE: Bulbostylis capillaris, 6, O; 810, 869. Carex annectens, 9, O; 193. C. blanda, 11, O; 162. *C. complanata, 4, 9, C; 221a, 264. *C. crinita var. crinita, 5, 6, A; 242. C. debilis, 9, O; 161. C. festucacea, 9, C; 356. C. flaccosperma, 6, SC; 152. C. frankii, 5, 6, C; 556, 1655. C. grisea, 9, SC; 1581. C. howei, 9, R; 269. C. incomperta, 5, 6, O; 154. *C. intumescens, 9, C; 214, 266. C. laevivaginata, 5, 6, O; 124. C. laxiculmis, 9, SC; 46. *C. lupulina, 9, O; 1108. *C. lurida, 6, 9, A; 151, 456a. C. pensylvanica, 9, SC; 1293. C. prasina, 9, SC; 1385. C. projecta, 9, O; 290. C. retroflexa, 10, SC; 1394. C. rosea, 6, SC; 1406. C. scoparia, 6, SC; 155, O, 1674. C. sparganioides, 4, SC; 225. *C. squarrosa, 5, SC; 1704-7. C. stricta, 6, SC; 1422. C. styloflexa, 9, O; 1339. C. tribuloides, 9, O; 290. C. vulpinoidea, 4, 6, C; 224, 398. ***Cyperus esculentus, 4, SC; 409. C. flavescens, 6, O; 651. C. ovularis, 4, 6, C; 1028, 1088. C. strigosus, 4, 6, A; 494, 1024. **C. tenuifolius, 4, 6, O; 1051. Eleocharis engelmannii, 4, SC; 1141. E. obtusa, 6, C; 1089, 1125. **E. quadrangulata, 6, SC; 311. E. tenuis, 6, SC; 372. Fimbristylis autumnalis, 6, O; 811, 1134. ***F. dichotoma, 4, SC; 970. Rhynchospora capitellata, 6, A; 883, 1128. ***R. chalarocephala, rocky portion of small stream, SC; 1063. ***R. microcephala, 9; 1149. Scirpus atrovirens, 6, C; 153, 839. S. cyperinus, 5, 6, 9, C; 919, 1058. S. polyphyllus, 5, 9, O; 622, 1046. **S. purshianus, 6, C; 817, 1024.

DIOSCOREACEAE: Dioscorea villosa, 9, O; 286.

IRIDACEAE: **Iris verna, 10, SC; 1356. Sisyrinchium angusti-folium, 4, 6, 10, O; 1450-1. S. mucronatum var. mucronatum, 4, 10, 11, C; 109.

JUNCACEAE: Juncus acuminatus, 6, O; 254, 1137. ***J. coriaceus, 5, SC; 1086. J. effusus, 5, 6, C; 210, 1093. J. marginatus, 4, SC; 1135. J. platyphyllus, 6, O; 867, 1073. J. scirpoides, 6, O; 310, 1136. J. tenuis, 4, A; 322. ***Luzula bulbosa, 9, O; 168. L. echinata, 5, 9, O; 114, 249.

LILIACEAE: Aletris farinosa, 13, O; 447, 1673. Allium vineale, 3, 4, 7, A; 365. **Amianthium muscaetoxicum, 9, SC; 1562. Asparagus officinalis, 4; 379. **Chamaelirium luteum, 10, SC; 1538. Hemerocallis fulva, 2, 9, C; 364. Medeola virginiana, 12, SC; 1594. Muscari racemosum, 3, 4, C; 31. Ornithogalum umbellatum, 6, SC; 1383. Polygonatum biflorum, 9, 10, C; 200. Smilacina racemosa, 9, 10, C; 131. **Smilax bona-nox, 4, 9, O; 963-1. S. glauca, 9, 10, 13, C; 1061, 1575. S. herbacea, 9, 10, O; 1373. S. hispida, 9, O; 1526. S. rotundifolia, 4, 9, A; 263. Uvularia perfoliata, 10, C; 823, 1317. U. sessilifolia, 10, SC; 1566. ***Yucca filamentosa var. smalliana, 4, C; 231.

ORCHIDACEAE: Aplectrum hyemale, 10, SC; 1287. Corallorhiza odontorhiza, 13, O; 1071, 1082. Cypripedium acaule, 11, 13, 14, O; 89. Goodyera pubescens, 9, 10, O; 544. Habenaria clavellata, 5, 9, O; 502, 573. H. lacera, 5, 9, O; 509, 1669. Liparis lilifolia, 10, R; 502, 649. Malaxis unifolia, 13, SC; 1681. Orchis spectabilis, 9, SC; 133. Spiranthes cernua var. cernua, 6, SC; 1119. S. gracilis var. gracilis, 11, 13, O; 640, 688. **S. grayi, 13, 14, O; 950, 1072. **S. ovalis, 9, O; 832, 1053. **S. vernalis, 6, SC; 452. Tipularia discolor, 13, O; 609.

POACEAE: Agropyron repens, 4, SC; 251, 326. Agrostis hyemalis, 4, SC; 1522. A. perennans, 10, 11, 12, A; 792. A. stolonifera, 3, 4, 7, A; 299, 434. ***Aira caryophyllea, 4, C; 1448. ***A. elegans, 4, O; 1646. Andropogon scoparius, 13, 14, O; 1096. A. virginicus, 4, 7, A; 1026. Anthoxanthum odoratum, 4, 9, O; 107, 284. Aristida dichotoma, 4, A; 911. **A. lanosa, 7, SC; 1143. A. longespica, 4, SC; 973. A. oligantha, 4, C; 838. **A. purpurascens, 4, SC; 1056. ***Arthraxon hispidus var. cryptatherus, 6, 9, O; 905. Avena sativa, rarely escapes, 4; 1504. Bromus commutatus, 4, O; 240. B. japonicus, 4, C; 148. B. purgans, 9, C; 1034, 359. B. polyanthes, 4, C; 429, 780. B. scoparium, 6, 7, C; 401a, 798. B. stipatum, 5, 6, C; 616. Paspalum laeve, 4, 6, A; 1007, 493. ***P. setaceum, 6, SC; 880. Phleum pratense, 3, 4, A; 245. Poa annua, 4, A; 35. P. autumnalis, 9, O; 1489. P. compressa, 8, 9, O; 319, 1673. P. cuspidata, 9, O; 18. P. pratensis, 4, A; 121, 204. Setaria faberi, 3, 4, LA; 946, 1022. **S. geniculata, 4, C; 662, 1043. S. glauca, 4, C; 937, 1131. S. viridis, 4, O; 328. Sorghastrum nutans, 4, 14, O; 1079, 1113. Sorghum halepense, 3, LA; 329, 1087. Sphenopholis nitida, 9, O; 1377. S. obtusata, 7, 8, O; 1457, 1647. Sporobolus clandestinus, 4, SC; 973a. Stipa avenacea, 12, R; 1319. Tridens flavus var. flavus, 4, 7, A; 771. Tripsacum dactyloides, 4, O; 402a, 991. Trisetum pensylvanicum, 12, SC; 1419. Triticum aestivum, an occasional escape, 4; 184. **Uniola laxa, 9, O; 797, 857. Zea mays, rarely escapes, 4; 565.

POTAMOGETONACEAE: ***Potamogeton epihydrus, 1, SC; 248.

SPARGANIACEAE: **Sparganium americanum, 5, 6, R; 399.

TYPHACEAE: Typha latifolia, 5, 6, O; 418.

XYRIDACEAE: Xyris torta, 5, 6, R; 586.

DICOTYLEDONEAE

ACANTHACEAE: Justicia americana, on gravel or sand bars in Kent Branch, O; 283. Ruellia caroliniensis, 10, 13, O; 463.

ACERACEAE: Acer negundo, 9, O; 1110. A. rubrum, 8, 9, A; 1298.

AIZOACEAE: Mollugo verticillata, 4, C; 386.

B. tectorum, 4, O; 239. Cinna arundinacea, 9, A; 803, 1100. Dactylis glomerata, 3, 4, A; 208. Danthonia sericea, 12, O; 1511, 1649. D. spicata, 4, C; 256. Digitaria ischaemum var. ischaemum, 4, 5, A; 806. D. sanguinalis, 4, O; 661. Echinochloa crusgalli, 4, A; 981. Eleusine indica, 4, C; 394, 436. Elymus riparius, on sandbar in stream, SC; 958. E. villosus, 4, SC; 1130. E. virginicus, 4, 5, 8, O; 433, 900. ***Eragrostis cilianensis, 4, SC; 1683. ***E. curvula, 4, SC; 1445. E. spectabilis, 4, 6, O; 881, 945. ***Erianthus giganteus, 6, SC; 1023. Festuca elatior, 3, 4, 7, A; 149, 253. F. myuros, 4, O; 298. F. obtusa, 9, 10, C; 360. F. octoflora, 4, 7, C; 1520. F. rubra, 4, 14, O; 313, 1460. Glyceria striata, 5, 6, 9, C; 317, 348. **Gymnopogon ambiguus, 14, SC; 1070. Holcus lanatus, 4, 6, C; 211a, 361. **Hordeum pusillum, 4, O; 252. Hystrix patula, 9, C; 277. Leersia oryzoides, 5,6, O; 783, 807a. L. virginica, 6, SC; 894. ***Lolium multiflorum, 4, O; 250. L. perenne, 4, SC; 1684. Melica mutica, 10, 12, O; 287, 1320. **Miscanthus sinensis, 2, O; 940, 976. ***Muhlenbergia capillaris, 14, SC; 1151. M. schreberi, 4, A; 1021, 1054. ***M. sylvatica, 9, SC; 1102. Panicum anceps var.

anceps, 4, A; 453. P. boscii, 13, O; 875. P. capillare, 4, C;
860. P. clandestinum, 6, 9, A; 903. P. commutatum, 6, O; 255,
613. P. depauperatum, 4, O; 1445-1. P. dichotomiflorum, 4, A;
949, 969-1. P. dichotomum, 4, A; 221. P. lanuginosum, 4, O; 430.

AMARANTHACEAE: Amaranthus hybridus, 4, A; 570, 571. A. spinosus,
4, A; 395.

ANACARDIACEAE: Rhus copallina, 4, 8, A; 1453-1. R. glabra,
7, 8, C; 412. R. radicans, 4, 8, 9, A; 602. R. toxicondendron,
13, Q; 870.

ANNONACEAE: Asimina triloba, 9, C; 1019.

APIACEAE: Angelica venenosa, 5, 6, O; 514. Cicuta maculata,
6, O; 704. Cryptotaenia canadensis, 9, O; 276, 753. Daucus carota,
4, 7, A; 458. Hydrocotyle americana, 9, O; 1677-1, 288. Oxypolis
rigidior, 5, SC; 898.   Sanicula canadensis, 9, O; 1682. **S. smallii,
9, 10, C; 199, 1515. Thaspium barbinode, 4, O; 170, 518. T.
trifoliatum var. trifoliatum, 12, R; 1440-1. Zizia aptera, 10,
SC; 1698.

APOCYNACEAE: Apocynum cannabimum, 4, C; 220, 615. Vinca
minor, 2, C; 15.

AQUIPOLIACEAE: Ilex opaca, 11, 13, A; 1248. I. verticillata,
9, O; 268.

ARALIACEAE: Aralia racemosa, 9, R; 925.

ARISTOLOCHIACEAE: Aristolochia serpentaria, 10, C; 1044,
1464. Hexastylis virginica, 12, C; 53.

ASCLEPIADACEAE: Asclepias incarnata var. pulchra,
6, O; 513. A. purpurascens, 9, SC; 1101. A. syriaca, 4, C, 320.
A. tuberosa, 4, O; 335. A. viridiflora, 4, O; 633. Matelea
carolinensis, 9, SC; 1692.

ASTERACEAE: Achillea millefolium, 4, A; 607. A. millefolium
forma rosea, 4, SC; 191. Ambrosia artemisiifolia, 4, A; 710.
A. trifida, 6, SC; 1106. Antennaria plantaginifolia var. arnoglossa,
14, SC; 66. A. plantaginifolia var. plantaginifolia, 4, 8, A; 29.
Anthemis arvensis, 4, O; 1435. Arctium minus, 4, O; 567. ***Artemisia
ludoviciana, 2, SC; 965. Aster divaricatus, 9, C; 901. **A. dumosus,
4, O; 724. A. infirmis, 12, O; 577. A. patens, 4, SC; 1105.
A. paternus, 4, 13, C; 259. A. pilosus var. pilosus, 4, 8, C;
1129. A. puniceus, 5, O; 1068. A. simplex, 9, O; 1142. A. undulatus,
12, SC; 873. ***A. vimineus, 4, 8, O; 1126. Bidens aristosa,
4, O; 1138. B. bipinnata, 4, A; 669. B. frondosa, 4, 5, C; 790,
834. **B. polylepis, 4, C; 947. B. tripartita, 5, 9, O; 899.
Cacalia atriplicifolia, 4, 9, O; 527. *Carduus discolor, 4, A;
852. C. lanceolatus, 4, A; 629. C. pumilus, 4, A; 467. Centaurea
maculosa, 4, C; 336. Chrondrilla juncea, 4, SC; 1476. Chrysanthemum
leucanthemum, 4, C; 229. Chrysogonum virginianum var. virginianum,
10, C; 77, 226a. *Cichorium intybus, 4, A; 238. **Coreopsis auriculata,
12, O; 1393, 1429. **C. lanceolata, 4, O; 140. C. verticillata,
4, 8, C; 232. Eclipta alba, 4, O; 657. Elephantopus carolinianus,
9, 10, C; 642, 818. **E. tomentosus, 9, O; 733. Erechtites
hieracifolia, 4, C; 708. Erigeron annuus, 4, A; 302. E. canadensis,
var. canadensis, 4, C; 566, 848. E. canadensis var. pusillus, 4, C;
647. E. pulchellus, 10, SC; 1366. E. strigosus, 4, A; 143.
Eupatorium album, 13, O; 1069. E. aromaticum, 11, C; 789. E. coeles-
tinum, 2, SC; 987. E. fistulosum, 5, 6, C; 706. E. hyssopifolium,

4, O; 758. E. perfoliatum, 6, C; 668. E.rotundifolium var. ovatum,
6, 9, C; 628. E. rugosum, 9, C; 759. Galinsoga ciliata, 4, SC;
1045. Gnaphalium obtusifolium, 4, C; 916. G. purpureum var.
purpureum, 4, C; 179. Helenium autumnale var. parviflorum,
5, 9, O; 908, 923. H. flexuosum, 5, 6, O; 304, 339. **Helianthus
atrorubens, 4, O; 876. H. decapetalus, 9, SC; 749. H. divaricatus,
4, O; 592-1. H. strumosus, 4, SC; 547. **H. tuberosus, 3, SC;
1067. Heliopsis helianthoides, 4, C; 614, 627. Heterotheca mariana,
4, 8, 13, A; 637, 849. Hieracium gronovii, 12, SC; 681. ***H. pilosella,
5, 6, O; 1473. H. pratense, 4, 8, 13, C; 166. H. scabrum, 4, SC;
770. H. venosum, 4, 13, A; 172. Hypochoeris radicata, 4, O; 417.
Krigia dandelion, 9, O; 1349, 1412. K. virginica, 4, O; 56. Lactuca
canadensis, 4, C; 461. L. floridana, 9, O; 1003. L. scariola,
4, C; 497. Liatris squarrosa, 4, 14, O; 1077. Mikania scandens,
5, C; 612. Parthenium integrifolia, 4, SC; 1635. Prenanthes
serpentaria, 4, 8, O; 957. *Pyrrhopappus carolinianus var.
carolinianus, 4, C; 190. Rudbeckia fulgida, 4, SC; 1012. R. hirta,
4, 7, A; 307. R. laciniata, 9, A; 591. Senecio aureus, 5, 9, C;
134. S. smallii, 4, C; 141. Silphium trifoliatum, 7, 8, O; 555.
Solidago altissima, 4, C; 959. S. bicolor, 8, C; 887. S. caesia,
8, 9, C; 751. S. erecta, 4, 13, O; 951. S. gigantea, 4, 7, C;
619. S. graminifolia, 4, O; 975. S. juncea, 4, 7, C; 549, 796.
S. nemoralis, 8, 13, C; 829, 888. **S. odora, 4, O; 933. **S.
puberula, 4, C; 983, 1057. S. rugosa var. rugosa, 11, 13, C;
967, 979. Sonchus asper, 4, SC; 321. Taraxacum officinale, 4, A;
341. **Tragopogon dubius, 4, R; 1413. **T. porrifolius, 4, O;
146. Verbesina alternifolia, 4, 6, C; 992. Vernonia glauca,
8, O; 598. V. noveboracensis, 6, C; 1033. Xanthium strumarium var.
glabratum, 4, O; 968. X. strumarium var. strumarium, 4, SC; 869-1.

BALSAMINACEAE: Impatiens capensis, 5, 9, A; 510.

BERBERIDACEAE: *Podophyllum peltatum, 9, C; 1321.

BETULACEAE: Alnus serrulata, 9, A; 744, 1194. Betula nigra,
9, C; 1384. Carpinus caroliniana, 9, A; 589. Corylus americana,
9, O; 283a.

BIGNONIACEAE: Campsis radicans, 4, O; 489, 380. Catalpa
speciosa, 4, SC; 1663.

BORAGINACEAE: Hackelia virginiana, 9, 10, O; 687. Lithospermum
arvense, 4, LA; 10. Myosotis verna, 4, 6, O; 1322.

BRASSICACEAE: Arabis canadensis, 12, SC; 1672. Arabidopsis
thaliana, 4, C; 87. Barbarea verna, 4, C; 14. B. vulgaris var.
arcuata, 4, O; 32. **Brassica napus, 4, C; 9. Capsella bursa-
pastoris, 4, C; 30. Cardamine bulbosa, 9, SC; 1270. C. concatenata,
9, SC; 1275. C. hirsuta, 4, A; 6. C. pensylvanica, 5, 9, C; 73.
Draba verna, 3, 4, C; 27. Lepidium campestre, 4, O; 88. L. virginicum,
4, C; 185. Sisymbrium officinale var. leiocarpum, 4, O; 392.
**Thlaspi perfoliatum, 4, SC; 33.

CALLITRICHACEAE: Callitriche heterophylla, 1, 5, O; 1291.

CAMPANULACEAE: Campanula aparinoides, 5, 6, R; 548. Lobelia
cardinalis, 9, O; 505, 667. L. inflata, 4, 6, C; 485, 563. L.
puberula, 6, 9, O; 716, 877. L. spicata, 8, 10, 13, O; 163, 400.
Specularia perfoliata, 4, C; 195, 308.

CAPRIFOLIACEAE: Lonicera japonica, 2, 4, 9, A; 227. Sambucus
canadensis, 6, 9, O; 241. Symphoricarpos orbiculatus, 2, 4, O; 481.

Viburnum acerifolium, 8, 13, O; 167. V. dentatum var. dentatum,
9, 13, O; 451. **V. nudum, 9, SC; 1666. V. prunifolium,
8, 9, O; 74.

CARYOPHYLLACEAE: Agrostemma githago, 4, SC; 176. Arenaria
serpyllifolia, 4, SC; 1481. Cerastium glomeratum, 4, 9, C; 1346.
C. holosteoides var. vulgare, 4, O; 1418. Dianthus armeria,
4, O; 147. Lychnis alba, 4, SC; 500. Saponaria officinalis,
4, 6, O; 459. Silene stellata, 12, SC; 576. Stellaria graminea,
6, 9, O; 177. S. media, 4, A; 342. S. pubera, 9, 10, C; 51.

CELASTRACEAE: Euonymus americanus, 9, 11, 13, C; 171.

CHENOPODIACEAE: Chenopodium album, 4, A; 939. C. ambrosioides,
4, C; 861.

CISTACEAE: Lechea racemulosa, 4, 8, O; 422, 840.

CONVOLVULACEAE: Calystegia sepium, 4, O; 439. C. spithamaea,
4, SC; 1472. **Convolvulus arvensis, 4, O; 338. Cuscuta campestris,
parasite growing on other plants, 4, O; 366. C. compacta, parasite
growing on other plants, 9, O; 926. Ipomoea hederacea, 3, 4, C;
384a. I. lacunosa, 3, 4, C; 384b. I. pandurata, 3, 4, A; 382.
I. purpurea, 3, 4, A; 468.

CORNACEAE: *Cornus amomum, 5, 9, O; 261, 435. C. florida,
10, 11, 13, A; 94.

CRASSULACEAE: Penthorum sedoides, 5, SC; 776. ***Sedum
spectabile, rarely escapes, 4; 969.

EBENACEAE: Diospyros virginiana, 4, 8, C; 295.

ERICACEAE: Chimaphila maculata, 11, 13, A; 330. C. umbellata,
13, 14, O; 1074. Gaylussacia baccata, 11, A; 1438. Kalmia latifolia,
12, C; 228. Lyonia ligustrina, 8, 9, O; 604, 284a. Monotropa
hypopithys, 13, SC; 464. M. uniflora, 13, C; 198. **Oxydendrum
arboreum, 9, 10, O; 1256. Pyrola rotundifolia var. americana,
9, 13; 822, 1579. *Rhododendron nudiflorum, 9, O; 79, 112.
Vaccinium atrococcum, 11, 13, 14, A; 1449-1. V. stamineum,
4, 11, 13, A; 99. V. vacillans, 4, 11, 13, A; 1441-1.

EUPHORBIACEAE: Acalypha gracilens, 4, O; 1049. A. rhomboidea,
4, O; 938. Croton glandulosus var. septentrionalis, 4, SC; 819.
Euphorbia corollata, 4, 8, C; 199, 562. *E. cyparissias, 2, SC;
1302. E. maculata, 4, C; 568. Phyllanthus caroliniensis, 5, 6,
O; 702, 884.

FABACEAE: **Albizia julibrissin, 4, O; 390. Amphicarpa bracteata.
13, O; 737. Apios americana, 5, 9, O; 1561. Baptisia tinctoria,
4, O; 271. Cassia hebecarpa, 6, 9, O; 582, 1066. C. fasciculata,
4, O; 624. C. nictitans, 4, C; 559. Cercis canadensis, 8, 10, 13,
O; 62. Crotalaria sagittalis, 4, O; 533. **Desmodium marilandicum,
13, C; 855. D. nudiflorum, 8, 13, C; 511. D. paniculatum, 8, 13,
C; 644. D. rotundifolium, 10, O; 1011. D. viridiflorum, 10, O;
1148. Galactia volubilis 8, 13, O; 425, 548. Gleditsia triacanthos,
9, SC; 1080. Lathyrus latifolius, 2, 4, O; 218. Lespedeza capitata,
4, 7, O; 966-1. L. cuneata, 4, O; 709, 835. L. hirta, 11, O; 764.
L. intermedia, 13, O; 645. L. procumbens, 4, O; 729, 932. L. repens,
4, C; 316, 760. L. stipulacea, 4, C; 672. L. striata, 4, O; 684.
L. virginica, 4, O; 726, 929. Medicago lupulina, 4, O; 590.
M. sativa, 4, O; 460. Melilotus alba, 4, C; 217. M. officinalis,
4, C; 192. Robinia pseudo-acacia, 4, 8, C; 1548. Strophostyles
umbellata, 4, O; 522. Stylosanthes biflora, 4, 7, O; 516.

Tephrosia virginiana, 4, O; 216. Trifolium agrarium, 4, SC; 333.
T. arvense, 4, O; 186. T. campestre, 4, C; 203. T. pratense,
4, A; 305. T. repens, 4, A; 127. Vicia angustifolia, 4, A;
98. V. caroliniana, 8, 9, O; 106, 1324. V. dasycarpa, 4, LA; 173.
***Wisteria frutescens, 2, SC; 1436.

FAGACEAE: Castanea dentata, stump sprouts, 11, R; 1470.
C. pumila, 8, 11, O; 373. Fagus grandifolia, 10, C; 1380.
Quercus alba, 10, 11, 12, 13, A; 741. Q. bicolor, 9, SC; 1145.
Q. coccinea, 11, C; 1030, 1146. Q. falcata, 11, 13, A; 984,
1032. Q. ilicifolia, 8, 11, O; 1640. Q. marilandica, 11, 13, C;
1442-1. Q. palustris, 9, O; 1036, 1038. Q. phellos, 4, 9, 13,
O; 1084. Q. prinus, 11, 12, C; 1551. Q. rubra var. rubra,
11, O; 742, 1144. Q. stellata, 11, A; 743, 762. Q. velutina,
11, C; 1642.

GENTIANACEAE: Bartonia virginica, 10, SC; 605. Gentiana
villosa, 7, SC; 856. Obolaria virginica, 10, R; 1261, 1273.
Sabatia angularis, 4, R; 611.

GERANIACEAE: Geranium carolinianum, 4, C; 119. G. maculatum,
10, O; 1328.

HAMAMELIDACEAE: Hamamelis virginiana, 9, O; 601. Liquidambar
styraciflua, 9, C; 941.

HYPERICACEAE: Hypericum gentianoides, 4, 8, C; 847. H.
hypericoides, 4, O; 533. H. mutilum, 5, 6, C; 495. H. perforatum,
4, C; 332. H. punctatum, 4, C; 357.

JUGLANDACEAE: Carya cordiformis, 9, O; 1037. Carya glabra,
11, C; 1147. C. tomentosa, 8, 11, C; 985, 1549. Juglans nigra,
2, 10, 13, O; 1492.

LAMIACEAE: Cunila origanoides, 12, SC; 872. Glecoma hederacea,
2, 4, LA; 90. Hedeoma pulegioides, 4, SC; 676. Lamium amplexicaule,
4, C; 7. L. purpureum, 4, O; 12. Lycopus americanus, 6, 9, O;
585. L. virginicus, 5, O; 980. ***Marrubium vulgare, 4, SC; 100.
Mentha piperita, 5, O; 641. **Monarda punctata, 4, SC; 995.
Perilla frutescens, 2, O; 948. Prunella vulgaris, 4, C; 475.
Pycnanthemum incanum, 4, O; 626. P. tenuifolium, 6, 7, O; 843.
Salvia lyrata, 4, 9, O; 137. ***Satureja calamintha var. nepeta,
4, LA; 408. S. vulgaris, 6, SC; 355. Scutellaria elliptica,
10, O; 331. S. integrifolia, 9, 13, C; 246. S. lateriflora,
6, O; 707. Trichostema dichotomum, 5, 6, O; 721.

LAURACEAE: Lindera benzoin, 9, C; 16. Sassafras albidum,
8, 13, C; 580.

LINACEAE: Linum striatum, 4, C; 534. L. virginianum,
var. medium, 4, O; 308. L. virginianum var. virginianum,
4, O; 558.

LOGANIACEAE: **Polypremum procumbens, 4, O; 564a, 863.

LYTHRACEAE: Cuphea viscosissima, 6, SC; 716. **Rotala
ramosior, 5, 6, O; 825.

MAGNOLIACEAE: Liriodendron tulipifera, 9, C; 630.

MALVACEAE: Malva neglecta, 4, C; 174. Sida spinosa,
4, C; 572.

MELASTOMATACEAE: **Rhexia mariana var. mariana, 4, 6, C;
389. R. virginica var. virginica, 4, 6, C; 663.

MENISPERMACEAE: Menispermum canadense, 9, R; 1531.

MORACEAE: _Morus rubra_, 2, 8, O; 833.

NYMPHAEACEAE: _Nuphar luteum_, 1, SC; 1000.

NYSSACEAE: _Nyssa sylvatica_ var. _sylvatica_, 11, 13, C; 850.

OLEACEAE: _Chionanthus virginicus_, 10, O; 851, 1133. _Fraxinus americana_, 13, O; 754. _F. pennsylvanica_, 9, O; 1002. _Ligustrum sinense_, 4, R; 1484.

ONAGRACEAE: _Circaea lutetiana_ ssp. _canadensis_, 9, O; 279. _Gaura biennis_, 4, SC; 917. _Ludwigia alternifolia_, 4, 5, 6, C; 456. **_L. decurrens_, 5, 6; R; 650. _L. palustris_, 5, 6, A; 353, 816. _Oenothera biennis_, 4, C; 664. _O. fruticosa_, 4, O; 588. **_O. laciniata_ var. _laciniata_, 4, O; 219.

OROBANCHACEAE: _Epifagus virginiana_, with _Fagus_, 10, O; 1015.

OXALIOACEAE: _Oxalis dillenii_, 4, O; 1507. _O. florida_, 4, SC; 1654. _O. stricta_, 4, 12, A; 1480, 1653. _O. violacea_, 9, O; 135.

PAPAVERACEAE: _Sanguinaria canadensis_, 9, 10, 12, O; 25.

PASSIFLORACEAE: **_Passiflora lutea_, 9, 13, O; 462, 1118.

PHRYMACEAE: _Phryma leptostachya_, 9, 13, O; 423.

PHYTOLACCACEAE: _Phytolacca americana_, 4, A; 267.

PLANTAGINACEAE: _Plantago aristata_, 4, LA; 296. _P. lanceolata_, 4, A; 188. _P. rugelii_, 4, A; 472. _P. virginica_, 4, 6, O; 309, 1292.

PLATANACEAE: _Platanus occidentalis_, 9, C; 519.

POLEMONIACEAE: _Phlox carolina_, 9, SC; 1539. _P. paniculata_, 2, SC; 757. **_P. subulata_, 2, 4, O; 1234.

POLYGALACEAE: **_Polygala curtissii_ 4, O; 487-1. _P. sanguinea_, 4, 6, R; 369. _P. verticillata_, 4, SC; 487.

POLYGONACEAE: _Polygonum arifolium_, 5, 6, O; 1010. _P. aviculare_, 3, 4, O; 470. _P. cespitosum_ var. _longisetum_, 4, 6, O; 807. _P. convolvulus_, 4, O; 325. _P. hydropiperoides_ var. _hydropiperoides_, 1, LA; 1674-1. **_P. lapathifolium_, 4, O; 537. _P. pensylvanicum_, 6, O; 902a. _P. persicaria_, 4, C; 407. _P. punctatum_, 5, O; 486, 731. _P. sagittatum_, 5, C; 730. _P. scandens_ var. _scandens_, 4, SC; 1116. **_P. setaceum_, 9, SC; 623. _Rumex acetosella_, 4, A; 118. _R. crispus_, 4, C; 237. _R. obtusifolius_, 4, O; 763, 1560. _Tovara virginiana_, 9, O; 752.

PORTULACACEAE: _Claytonia virginica_, 9, A; 17, 1316-1.

PRIMULACEAE: _Anagallis arvensis_, 4, SC; 583. _Lysimachia ciliata_, 9, 13, O; 236. _L. nummularia_, 5, O; 994, 1532. _L. quadrifolia_, 4, 8, O; 314.

RANUNCULACEAE: _Aconitum uncinatum_, 10, SC; 1040. _Anemone virginiana_, 8, 13, O; 401. _Cimicifuga racemosa_, 9, O; 924. _Clematis ochroleuca_, 12, O; 138. _C. virginiana_, 4, 9, O; 705. **_Delphinium ajacis_, escaped from cultivation, SC; 235. _Hepatica americana_, 9, 10, 12, O; 24. _Ranunculus abortivus_, 4, 9, C; 11, 54. _R. bulbosus_, 4, A; 84. _R. hispidus_, 10, SC; 1284. ***_R. parviflorus_, 4, SC; 1330. _R. recurvatus_, 9, C; 92. _Thalictrum polygamum_, 9, R; 1704-15. **_T. revolutum_, 9, O; 213. _T. thalictroides_, 10, 12, O; 50. **_Xanthorhiza simplicissima_, 9, A; 22, 1016.

RHAMNACEAE: _Ceanothus americanus_, 4, 8, 11, O; 315.

ROSACEAE: _Agrimonia parviflora_, 4, 9, C; 682, 802. _A. pubescens_, 4, 9, O; 593, 639. _Amelanchier arborea_, var. _arborea_, 7, 8, C; 64. ***_A. spicata_, 8, SC; 1631. _Aruncus dioicus_, 10, SC; 1567.

Crataegus uniflora, 7, 12, 13, O; 431, 1462. _Ouschesnea indica_, 6, SC; 1571. _Fragaria virginiana_, 4, A; 72. _Geum canadense_, 8, 9, O; 448. _G. virginianum_, 12, SC; 575. _Gillenia trifoliata_, 10, SC; 1521. _Malus pumila_, 2, C; 1241. _Physocarpus opulifolius_, 8, R; 265. _Potentilla canadensis_, 4, 9, 13, A; 55. _P. norvegica_, 4, SC; 411. _P. recta_, 4, C; 144. _P. simplex_, 4, 9, C; 132. _Prunus americana_, 4, SC; 1469, 1609. _P. angustifolia_, 2, C; 1243. _P. avium_, 2, O; 1245, 1645. _P. persica_, 2, C; 63. _P. serotina_ var. _serotina_, 8, 11, 13, C; 301. _Pyrus communis_, 2, O; 1244, 1255. _Rosa carolina_, 4, O; 233. _R. multiflora_, 4, SC; 1060. _R. palustris_, 5, SC; 1687. ***_R. wichuraiana_, 4, O; 234. _Rubus allegheniensis_, 7, 8, A; 128, 1371. _R. argutus_, 7, 8, A; 1416b. _R. flagellaris_, 4, C; 1448-1, 1471. _R. occidentalis_, 4, O; 278. _Sorbus arbutifolia_ var. _arbutifolia_, 7, O; 536. _Spiraea prunifolia_, 2, C; 1232.

RUBIACEAE: _Cephalanthus occidentalis_, 5, 6, O; 415. _Oiodia teres_, 4, C; 539. **_O. virginiana_, 5, 6, O; 345, 732. _Galium aparine_, 4, A; 181. _G. circaezans_, 9, C; 280. _G. obtusum_ var. _filifolium_, 4, 6, O; 1535. _G. obtusum_ var. _obtusum_, 4, 9, O; 197. _G. pilosum_, 4, C; 426. _G. tinctorium_, 5, 6, O; 1627. _G. triflorum_, 9, 10, O; 1688. _Houstonia caerulea_, 8, 11, 13, A; 59. _H. purpurea_, 8, 10, O; 159. **_H. pusilla_, 6, SC; 1278. _Mitchella repens_, 9, 11, 13, A; 4.

SALICACEAE: _Populus alba_, 2, 4, O; 419. _P. deltoides_, 2, O; 553. _P. grandidentata_, 8, O; 543. _Salix nigra_, 9, O; 1496. _S. sericea_, 9, O; 1266, 1352.

SANTALACEAE: _Comandra umbellata_, 4, 8, O; 1442.

SAURURACEAE: _Saururus cernuus_, 9, O; 378.

SAXIFRAGACEAE: _Chrysosplenium americanum_, 9, SC; 1251. _Heuchera americana_, 9, C; 226. _Hydrangea arborescens_ ssp. _arborescens_, 12, R; 785. _Philadelphus coronarius_, 9, SC; 376. ***_P. inodorus_, 2, R; 1620. _Saxifraga pensylvanica_, edge of small stream in rocky woods, SC; 1433. _S. virginiensis_, 12, O; 19.

SCROPHULARIACEAE: ***_Agalinis obtusifolia_, 4, O; 769. _A. purpurea_, 4, 7, O; 974. _A. tenuifolia_, 4, 11, 13, O; 858, 1139. _Aureolaria laevigata_, 11, O; 853. _A. pedicularia_, 4, O; 1788. _A. virginica_, 4, 11, O; 508, 631. _Chelone glabra_, on gravel bar in Kent Branch, SC; 1112. _Gratiola neglecta_, 6, O; 344. _Linaria canadensis_, 4, O; 180. _Lindernia anagallidea_, 5, O; 180. _L. dubia_, 5, O; 736. _Mimulus ringens_, 5, 6, O; 525. _Paulownia tomentosa_, 4, O; 942. _Pedicularis canadensis_, 9, O; 136. _Penstemon australis_, 5, O; 1625. _P. laevigatus_, 5, 8, 10, 13, O; 194, 1488. _Verbascum blattaria_, 4, C; 337. _V. thapsus_, 4, A; 457. _Veronica arvensis_, 4, A; 1252. _V. officinalis_, 4, 6, O; 165. _V. peregrina_, 10, SC; 1613. _V. serpyllifolia_, 9, O; 122.

SIMAROUBACEAE: _Ailanthus altissima_, 4, O; 620.

SOLANACEAE: _Datura stramonium_, 4, A; 405. _Physalis heterophylla_, 14, SC; 1076. **_P. virginiana_ var. _virginiana_, 4, SC; 241a. _Solanum americanum_, 4, O; 471, 670. _S. carolinense_, 3, 4, A; 189, 499. **_S. rostratum_, 4, SC; 658.

STAPHYLEACEAE: _Staphylea trifolia_, 9, SC; 1376.

ULMACEAE: _Celtis occidentalis_, 9, O; 1364. _Ulmus americana_, 9, O; 1035. _U. rubra_, 9, O; 542.

URTICACEAE: <u>Boehmeria cylindrica</u>, 4, 9, A; 490. <u>Pilea</u>

<u>pumila</u>, 9, C; 1109.

   VALERIANACEAE: <u>Valerianella radiata</u>, 4, 0; 1363.

   VERBENACEAE: <u>Verbena simplex</u>, 3, 4, 0; 388. <u>V. urticifolia</u>,

4, 0; 406.

   VIOLACEAE: <u>Viola cucullata</u>, 4, 9, A; 1344. <u>V. emarginata</u>,

var. <u>emarginata</u>, 4, C; 101, 1310. <u>V. fimbriatula</u>, 4, 0; 1301.

<u>V. palmata</u> var. <u>palmata</u>, 10, LA; 1410. <u>V. palmata</u> var. <u>sororia</u>,

12, 0; 1396. <u>V. palmata</u> var. <u>triloba</u>, 10, SC; 1272. <u>V. pedata</u>,

4, 0; 78, 1315. **<u>V. primulifolia</u>, 6, 0; 125. <u>V. rafinesquii</u>,

4, A; 13. <u>V. sagittata</u>, 4, 13, 0; 93.

   VITACEAE: <u>Parthenocissus quinquefolia</u>, 8, 9, A; 1370. <u>Vitis</u>

<u>aestivalis</u>, 9, 13, 0; 202. <u>V. labrusca</u>, 4, 8, 0; 1633. <u>V. riparia</u>,

12, 13, 0; 1662, 1676-1. <u>V. vulpina</u>, 9, 0; 1440.

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Interaction of 2,4-D and Dicamba with Chitin and Chitosan[1]

Margaret V. Kemp[2] and J. P. Wightman

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Abstract—The interaction of the natural marine polymer chitin and its deacetylated derivative chitosan with the pesticides Dicamba and 2,4-D in aqueous solution has been investigated. The uptake of pesticides was determined from changes in concentration as measured by ultraviolet spectroscopy. A significant uptake of 2,4-D by chitosan and of the Dicamba by chitosan and chitin was observed. Chitosan was studied by both scanning electron microscopy (SEM)/ energy dispersion analysis of X-rays (EDAX) and electron spectroscopy for chemical analysis (ESCA) before and after equilibration with 2,4-D. The mechanism of uptake of 2,4-D by chitosan is absorption based on kinetic measurements and the EDAX spectrum for chlorine. The ESCA spectra provided further evidence for the uptake of 2,4-D on chitosan.

Introduction

Chitin or poly-N-acetyl-D-gluosamine is a natural polymer found in the exoskeleton of insects, crabs, and other crustaceans. Muzzarelli (1977) has written an excellent summary of different aspects of chitin including its preparation, characterization and properties. In light of the abundance of chitin in the marine environment, it is surprising that only a few articles have been published on the interaction of pesticides with chitin. Early work by Lord (1948) reported that DDT is sorbed by chitin.

Work reported by Muzzarelli (1977) has shown that a certain class of nonionic pesticides called benzoylphenylureas are capable of halting chitin synthesis. In addition to nonionic pesticides, Weber (1972) has noted three other types of pesticides, namely, cationic, basic, and acidic. The basic pesticides exist in aqueous solutions as cations by the following mechanism:

$$R + H^+ \rightleftharpoons RH^+ \qquad [1]$$
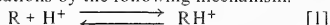
Acidic pesticides form anions in aqueous solution by the following mechanism:

$$RCOOH + H_2O \rightleftharpoons RCOO^- + H_3O^+ \qquad [2]$$
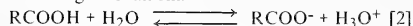
The objective of this research was to determine what types of pesticides would be capable of removal by chitin and its deacetylated derivative, chitosan, and to determine the mechanism of removal.

Experimental

Materials—Processed chitin (VITIN) and chitosan were obtained from the Velsicol Chemical Corporation, Chicago. The pesticides tested were Atrazine, 2,4-D, Propanil, Paraquat, and Dicamba. Samples of Atrazine, 2,4-D, Paraquat, and Dicamba were obtained from the Department of Plant Pathology and Physiology at Virginia Tech. Propanil was obtained from the Environmental Protection Agency, Research Triangle Park, N.C. All pesticides used in testing were technical grade.

Techniques—Ultraviolet spectra of dilute aqueous solutions of the pesticides were obtained using an Hitachi 100-60 spectrophotometer. Photomicrographs of chitosan were obtained using an Advanced Metals Research 900 scanning electron microscope (SEM). Qualitative analysis of chitosan was obtained using an energy dispersive analysis of x-rays (EDAX) attachment on the microscope. Electron spectroscopy for chemical analysis (ESCA) spectra of chitosan were obtained using a duPont 650 electron spectrometer with a Mg x-ray source.

Procedures—A stock solution of each pesticide was prepared in the following concentrations (c):

Pesticide	C (moles/ℓ)	λ max(nm)
Atrazine	4.63×10^{-5} M	225
2,4-D	2.27×10^{-3} M	285
Paraquat	5.83×10^{-4} M	262
Propanil	2.75×10^{-4} M	248
Dicamba	1.15×10^{-3} M	280

Each stock solution was then diluted with distilled water to make five -200 ml solutions with concentrations down to 20% of the stock solution. Each 200 ml solution was then divided into 50-ml portions. To two 50 ml solutions, 0.1 g of chitosan or chitin was added. A third 50 ml solution was used to make a calibration plot of absorbance (at a characteristic wavelength) vs. concentration. The wavelengths (λ) used for each compound are noted above.

Each flask was shaken manually once each hour for two hours after the sorbent was added. All of the flasks were then allowed to equilibrate for approximately 15-20 hrs. A small aliquot of the equilibrated solution was pipetted from the center of the flask and placed in the UV sample cell. Distilled water was used as a reference. The UV spectra of the calibration and equilibrated solutions of a particular pesticide were obtained within a 2-hour period.

Final concentrations of the solutions containing the sorbent were determined by interpolation from the calibration plot. The change in concentration was determined for each solution and a plot of VΔC/W vs. equilibrium concentration, C_f, was made to construct

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the sorption isotherm. Here V is the volume of solution
(50 ml in each case), ΔC is the change in pesticide
concentration on equilibration with W grams of the
sorbent.

Chitosan samples after equilibration with a 2.27 ×
10^{-3}M (initial) solution of 2.4-D were filtered and air
dried at 100° C for about 30 minutes. Some of the dried
flakes were then placed on copper conductive tape for
SEM analysis and on double stick tape for ESCA
analysis. The C 1s photopeak was used as a reference at
284.6eV.

A kinetic study of 2,4-D on chitosan was also per-
formed. A series of 11-50 ml flasks containing a 2.27 ×
10^{-3}M solution of 2,4-D were prepared. 0.1g chitosan
was added to each of the flasks at a time t=0. The UV
spectra of flask Nos. 1 and 2 were taken 30 and 60
minutes, respectively, after addition of the chitosan.
This process was repeated over the next 4½ hours for
flask Nos. 3-11.

Results and Discussion

Sorption isotherms—A significant uptake of 2,4-D on
chitosan was noted as shown in Figure 1. The shape of
the isotherm is somewhat peculiar, although Giles
(1969) and Bowman (1973) have reported similar
behavior albeit in different systems. The initial convex-
ity is suggestive of minimal interaction analogous to
the adsorption of gases on solids as determined by
Brunauer (1945). The linear increase at higher concen-
tration is suggestive of a solution process as was
observed by Dole (1972) for nitrophenol uptake from

FIG. 2—Isotherms for the uptake of Dicamba on chitosan and
processed chitin.

aqueous solution on Nylon. In short, the shape of the
isotherm does not permit ready interpretation in terms
of an adsorption process. Hence the term sorption is
used to describe the uptake of 2,4-D by chitosan. There
was no significant uptake of 2,4-D by chitin.

A significant uptake of Dicamba on both chitosan
and chitin was noted as shown in Figure 2. The shape
of the isotherms is quite similar to that observed for
2,4-D on chitosan (cf Fig. 1). The greater slope for
Dicamba on chitosan compared to chitin may suggest
a higher sorption of Dicamba on chitosan.

The kinetic results for the uptake of 2,4-D on chito-
san are shown in Figure 3. The linear dependence of
the quantity of 2,4-D taken up by chitosan as a func-
tion of the square root of time suggests a physical
process in which the rate is controlled by the diffusion
of 2,4-D into chitosan. A pseudo diffusion constant
(D) can be calculated from the equation

$$D = (S/C_i)^{1/2} \qquad [3]$$

where S is the slope in Figure 3 for an initial 2,4-
concentration of C_i. The average calculated D value is
0.134 ± 0.003 $\ell^{1/2}$ g$^{-1/2}$ min $-\frac{1}{4}$. The linearity of the

FIG. 1   Isotherm for the uptake of 2,4-D on chitosan.
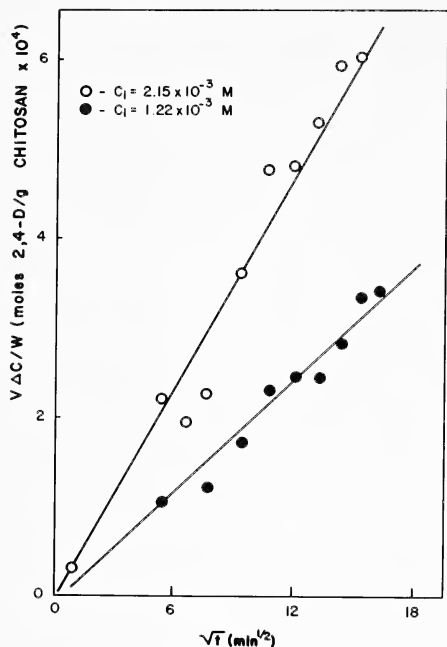
FIG 3— Kinetics of the uptake of 2,4-D by chitosan.

data in Figure 3 and the constancy of the value of D supports an uptake mechanism involving the absorption of 2,4-D by chitosan. It is suggested that Dicamba is also absorbed by both chitin and chitosan.

There was no significant uptake of Atrazine, Paraquat or Propanil on either chitin or chitosan. The finding that only the acidic pesticides which form anions in water are taken up suggests that the uptake may be related to the formation of anions. Muzzarelli (1977) has shown that many acids are sorbed onto chitin through salt formation or hydrogen bonding. The probable bonding site is believed to be the amino group due to protection of the hydroxy and ether groups on the glucosidic rings by solvation with water.

Scanning electron microscopy/energy dispersive analysis of x-rays (SEM/EDAX)—SEM photomicrographs of chitosan after equilibration with 2,4-D are shown in Figure 4. The EDAX spectrum for Cl in an equilibrated chitosan sample is also shown. No distinctive differences in surface features of chitosan before and after equilibration with 2,4-D was noted. Thus, the uptake of 2,4-D by chitosan does not result in changes in the surface morphology of chitosan. On the other hand, a significant chlorine EDAX signal is obtained
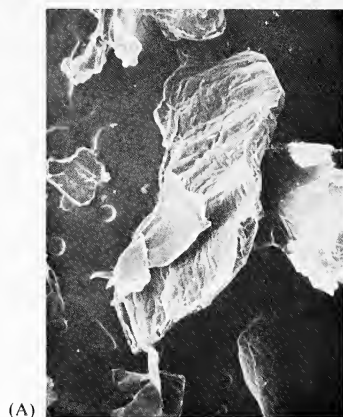
(A)

(B)
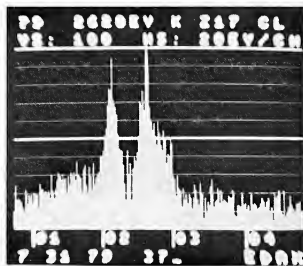
(C)

FIG. 4 SEM photomicrographs at 50X (A) and at 500X (B) of chitosan equilibrated with 2,4-D showing Cl in the EDAX spectrum (C).

for chitosan after equilibration with 2,4-D. Kang (1978) has shown that powdered silica with strongly absorbed HCl on the surface gives no significant Cl EDAX signal. The difference in these two sets of results again supports an absorption mechanism for the uptake of 2,4-D by chitosan.

Electron spectroscopy for chemical analysis (ESCA)— The C 1s, 0 1s, N 1s, and Cl 2p photopeaks obtained for chitosan equilibrated with 2,4-D are shown in Figure 5. The binding energies (B.E.) and atomic fractions (A.F.) for the major photopeaks of chitosan and equilibrated chitosan are given in Table 1. The significant result here is that Cl is observed in equilibrated chitosan but not in unequilibrated chitosan. This result again demonstrates the uptake of 2,4-D on chitosan.
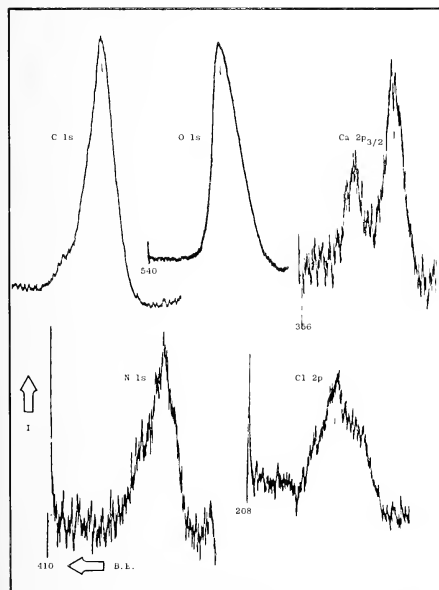
FIG 5—Major ESCA photopeaks of chitosan after equilibration with 2,4-D.

TABLE 1

ESCA Parameters for Chitosan and Chitosan/2,4-D

Element	CHITOSAN		CHITOSAN/2,4-D	
	B.E. (ev)	A.F.	B.E. (ev)	A.F.
N 1s	399.6	0.04	399.6	0.03
Cl 2p	-	-	200.2	0.01
O 1s	532.2	0.20	532.4	0.23
C 1s	(284.6)	0.76	(284.6)	0.71
Ca 2p$_{3\ 2}$	346.8	<0.01	347.3	0.02

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Analysis of Predictor Variables of Student Achievement in General Education in Two Regional State Universities

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Abstract—The purpose of this study was to explore relationships between selected demographic and cognitive variables and general education achievement and to identify variables that would predict achievement in general education programs in regional state universities.

This study involved undergraduates and graduates from two regional state universities. The first sample consisted of five hundred and thirty-five subjects from a Mid-Atlantic regional state university. The graduating classes from 1975 through 1979 comprised the population for the sampling. A random selection process was used to select the subjects, 100 from each class who took the general education section of the National Teacher Examination. Scores obtained by this sample of the population on the general education section of the NTE were examined in relation to cognitive and demographic predictor variables.

The second sample consisted of 79 undergraduate students from a South-Atlantic regional state university, who were administered the College Outcome Measures Project (COMP) Test. The COMP stresses generic outcomes necessary for effective adult roles in contrast to the NTE which stresses content mastery in disciplines. Scores obtained on the COMP were examined in relation to the same list of cognitive and demographic predictor variables used for the first sample.

The study design was basically longitudinal *ex post facto*. The principal statistical application was a step-wise multiple regression analyses. Eight hypotheses were developed to test the propositions of the study.

When first teaching psychology courses in a general education program, I was struck by the great variation among the students' achievement in their courses. Some students absorbed a great deal of the material, and others seemed more interested in courses in the department of their major. Females seemed more interested and appeared to have learned more than males; out-of-state students seemed to have learned more about college, generally, than did Virginia students.

I wondered if these variations would show up in the traditional exit tests from college such as the general education section of the National Teacher Examination (NTE), the Professional and Career Examination (PACE, a Civil Service Examination), and among scores from other outcome measures for college such as the Cooperative Test of General Culture.

When I began to read in this area, I was amazed by the general lack of studies in the area. While we have many studies predicting success in all college courses as defined by grades, we have few that look at test scores as outcomes. Also, there are few which look at general education and none that I could find that look at prediction in general education alone. The purpose of this study was to identify variables that will predict

achievement in general education by exploring relationships between selected variables and general education achievement.

Regional state universities were chosen for the study because of the uniformity of the programs of general education in such universities. Harcleroad (1973) discusses this issue in his book entitled *Regional State College and Universities Entering the 1970's*. Since little or no research existed, I decided an analysis of predictor variables of student achievement in general education in regional state universities would be timely. Most general education programs in regional state universities are about 35 years old and most have been developed along the lines of the Harvard Report of 1945: *General Education in a Free Society*. Regional state universities also educate about a fourth of the students in American colleges, as they serve a region or quadrant of the state and are, therefore, near their clientele. Some examples are Western Michigan, Central Michigan, and Northern Michigan Universities. The schools in my study were labeled the Mid-Atlantic and South-Atlantic samples. These labels coincide with the Educational Testing Service and American College Testing Service labels for test score and analysis.

Method

A sample was generated that consisted of graduates of a regional state university who had completed the general education section of the National Teacher's Examination (NTE/GES) over a five year period. This first sample of NTE scores was labeled the South-Atlantic sample and consisted of 535 graduates. A second sample was labeled the South-Atlantic sample and consisted of 79 students who completed the new American College Testing Program's Outcome Measures Project Test (ACT/COMP). The students in this sample were younger and had completed at least 75% of a 48 credit general education program.

The general education programs of both sampled institutions stressed broad learnings in three areas: humanities, social sciences, and natural sciences. The tests stressed the same areas, but the ACT/COMP was designed to test the applications of these learnings in adult life while the NTE/GES was designed to test knowledge alone. The areas tested are English expression, social studies, arts and literature, mathematics, science, and verbal reasoning.

For each of the subjects in the sample, I gathered demographic and cognitive data designed to fit into

multiple regression equations as potential predictor variables. These data consisted of age, sex, socioeconomic status (SES), high school rank (HSR), high school quality point average (HSQPA), college quality point average (CQPA), state/non-state residence, dormitory/non-dormitory status, major, and standardized test scores: Scholastic Aptitude Test (SAT), American College Test (ACT), Graduate Record Examination (GRE), and School College Aptitude Test (SCAT). Their variables represented the independent predictor variables for the study while the NTE/GES and the ACT/COMP served as the dependent or outcome variables.

This research was a longitudinal ex post facto design as outlined in Kerlinger (1973). It involved samples of students, their records of achievement, and their personal attributes. These data are programmed into a stepwise multiple regression equation. Two tests of significance were applied: an F test for R² which indicates the significance of the variance accounted for and an F test for b in which the relative strength and significance of the individual variables is presented.

The step-wise multiple regression analysis technique was selected because it is a standard procedure for addressing the underlying problem of the study. A number of important products are provided by the multiple regression analysis. The amount of variance is measured by the square of the multiple correlation between achievement and the predictor variables. The second product is the equation. This equation takes the following form:

$$y + k + b_1x_1 \ldots b_nx_n$$
where
y = the predicted criterion
k = a constant
b_1, n = a particular predictor variable

One limitation of the multiple regression equation is that there is no way of determining the precise contribution of the predictor variables because of the units involved. This confounds the order of contributions to the predictions; therefore, standardized regression weights were examined. The final product of this statistical technique was a multiple correlation between all significant predictors and the outcome variables (the NTE general education section and the COMP examination.

Results

A chart summarizing major results is presented herein. Demographic data such as age, sex, and socioeconomic status failed to explain a significant amount of variance in a stepwise multiple regression equation on either the NTE/GES or on the COMP test. There is no significant relationship between high school rank in class, college quality point average and scores on the GES or the COMP test. Academic major failed to explain a significant amount of variance on either the GES or COMP. Dormitory versus commuter status failed to explain a significant amount of variance on either test. Finally, there was no relationship between regional or non-regional residence on either test.

Outcome Variables	% of Variance Explained	Top Predictors
CES of NTE (when the data were disaggregated according to major for Liberal Arts majors (the liberal arts majors were certifying to teach in secondary schools)	39%	SAT, SCAT, GRE
Elementary Education Majors	34%	SAT, CQPA, GRE
Business Majors	47%	SAT, GRE
CES of NTE Segregated by Sex		
Females	44%	SAT, CQPA, SCAT, GRE
Males	43%	SAT, SCAT, GRE
COMP	19%	CQPA, SAT/ACT
COMP hierarchial regression equation	17%	CQPA, HSR

On the other hand, the SAT, ACT, SCAT, and GRE explained a significant amount of the variance (15-47%) in a stepwise multiple regression analysis on the NTE/GES and COMP. The standardized test (SAT, ACT, SCAT, and GRE) scores reached a level of significance, along with CQPA and HSQPA on both the NTE/GES and COMP. CQPA and HSQPA, along with socioeconomic status, reached a level of significance when data were separated according to sex and major. Most of the variance was explained by these variables on both the NTE/GES and the COMP Test.

Recommendations

The writer strongly recommends that replications of the present study be done in other regional state universities in other sections of the country and that the replications utilize the Comprehensive College Outcome Measure Project (COMP) test in regional state universities. The writer also recommends that research studies be undertaken that utilize a combination of HERL-K1T (a self-analysis kit) and the comprehensive COMP test as data gathering instruments. Finally, the writer suggests that longitudinal followup in ascertaining behavioral changes and "value added" attributable to general education. Withey, et al. (1971) have documented these phenomena for the college experience in *A Degree and What Else.* Separating out general education contributions has not been done and should be of great interest and value.

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Science In-Service Training and Elementary Teacher's Attitudes Toward Teaching Science[1]

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Abstract—An attempt was made to determine if a two-week period of intensive instruction in science content and two follow-up in-service sessions during an academic year can be effective for changing elementary school teachers' attitudes toward teaching science. Results were inconclusive but indicated that content training may indirectly facilitate changes in elementary teachers' attitudes toward teaching science when the teachers use the content knowledge in providing science instruction for their students.

Introduction

There appears to be increasing concern among science educators that science instruction is not being given adequate emphasis at the elementary school levels. Among the findings of DeRose, Lockard, and Paldy (1979:37) in their search of reports on National Science Foundation (NSF) studies was that less than half of the elementary school children in the U.S. are likely to experience a single school year in which they receive a significant amount of effective science instruction. The reports also indicated that science is given lower priority than other academic areas in the elementary school curriculum. Ankney and Rogers (1976:10) related that among the reasons elementary school teachers give for not teaching science are they do not like science and they do not know enough about it to feel comfortable and confident about teaching it.

One strategy for addressing the problems of lack of quantity and quality in science instruction for elementary school children is to provide elementary school teachers with enough of the right type of in-service training to help them feel better about teaching science or to help them develop better attitudes toward teaching science. The assumption is that improvements in teachers' attitudes will facilitate their teaching more science and doing a better job of teaching it.

A study of Spooner and Simpson (1979) indicated that even a five-day workshop involving teachers in "hands-on" experiences with science materials may improve the teachers attitudes toward teaching science. Studies by Moore (1975) and Gabel and Rubba (1979) revealed that participation in short-term (several weeks) workshops on new science curricula is effective for changing elementary teachers' attitudes toward science and science teaching but the changes do not persist over time.

Problem

The purpose of this study was to determine if a two-week period of intensive (6 hours per day) instruction in science content and two brief follow-up in-service sessions over the period of an academic year would be effective for changing elementary school teachers' attitudes toward teaching science. An attempt was also made to assess changes in the teachers' science knowledge. Though Shrigley (1974) did not find a relationship between pre-service elementary school teachers' knowledge of science content and their attitudes toward science and teaching science, it is conceivable that increased knowledge of science content will cause in-service teachers to be more confident about teaching science or to have more positive attitudes toward teaching science.

Method

The subjects for this study were 17 elementary school teachers who were participants in a NSF sponsored program designed to improve the teachers' abilities to teach science through increasing their knowledge and understandings of science content and processes. The program included a concentrated two-week period of science learning experiences during the summer when university professors in several science content areas and in science education guided the teachers through activities or made presentations. Two Saturday follow-up sessions, one in November and one in late March of the same academic year, also included content training and some sharing of experiences among the teachers about using the content in their classrooms. No specific commercial science program was followed in the in-service sessions but effort was made to cover the life and physical science topics commonly found in the commercially available elementary science programs. Such topics as Matter and Energy, Motion, Organisms, and Ecosystems were included and the methods of instruction varied accord-

ing to topics and instructors. The participating teachers were also able to request assistance from the university professors for information and consultant services during the academic year. Many of them took advantage of the available assistance.

The teachers were asked to respond to items on an attitude measure and a science content measure at three different times—prior to receiving any instruction, after the two-week summer instructional session, and then near the end of the academic year.

The attitude instrument used was The Survey of Opinions Toward Elementary School Science Scale developed by Spooner and Simpson (1979). The instrument contains 20 items requiring responses to a Likert-type five-point scale ranging from strongly agree to strongly disagree. This instrument was chosen because the items related to opinions about teaching elementary school science which were not directly related to the content covered in the in-service sessions. Also, the writer thought this instrument would facilitate comparisons between the scale developers' findings based on a very short period of in-service involvement and findings based on a longer period of in-service. Spooner and Simpson reported the internal consistency of the instrument as .69 and .72 for 97 elementary teachers' pretest and posttest scores in their sample using Cronback's Alpha.

The Sequential Tests of Educational Progress (STEP) Science Test: Series II, Form 2A was used as the content measure because it was thought to be on an appropriate level based on the teachers previous science content training and it assesses knowledge of several areas of science content thought to be related to some of the content covered in elementary science programs. However, the content covered in the in-service sessions was not identified based on the test. A comparison study done subsequent to the last in-service session indicated the content addressed in most items of the test had not been covered in any direct manner in the sessions. The portion of the content test used contained 45 items.

Results

Means and standard deviations were calculated for the teachers' total scores on the content measure and the attitude measure at each administration of the measures. These data are presented in Table 1. Results of correlated t-tests to compare the scores obtained at each administration of the tests are shown in Table 2.

TABLE 1

Means and Standard Deviations for Total Scores on Content and Attitude Measures

Test	Pretest		Post Two-week Period		Post Academic Year	
	Mean	SD	Mean	SD	Mean	SD
Content	29.06	6.69	30.24	8.04	32.82	5.44
Attitude	80.82	6.99	82.59	6.92	85.76	5.78

TABLE 2

The t-Values Based on Comparing Scores From Each Administration of The Measures

Test	Pretest vs. Post Two-weeks	Pretest vs. Post Academic Year	Post Two-weeks vs. Post Academic Year
Content	2.65*	5.05**	1.03
Attitude	1.08	2.49*	2.41*

* p < .05

** p < .01

The results indicate that the teachers made significant gains on the content and attitude measures over the experimental period. As expected the greatest content gains were made during the two-week period of content instruction. Actual gains were probably greater than indicated by the data but the content measure used did not contain items to assess understanding of much of the content covered in the instructional sessions. Of major interest was the indication that the significant positive changes in attitude toward teaching science did not occur during the two-week instructional period, but did occur during the academic year follow-up period when the teachers were probably using the content information in instructing their students. However, tests of linear correlation indicated no relationship between content gains and positive changes in attitude.

Conclusions and Comments

The study results do not provide conclusive evidence that elementary school teachers' attitudes toward teaching science can be changed through instruction in science content related to the content they are expected to teach. However, the fact that greater positive attitude changes occurred during the follow-up in-service period may mean that the increased knowledge of science content along with the follow-up assistance and support facilitated improvements in teachers' attitudes as they were using some of the content in instructing their students. In response to a structured survey instrument administered at the end of the academic year period, the teachers indicated that becoming more knowledgeable about science content and process had made them more confident in teaching science to their students, and consequently they actually taught science more often and more effectively. However, because no direct relationship was found between measured content gains and the attitude changes, other factors such as teaching environment and amount and type of science instruction required locally may have influenced or caused the measured attitude changes.

Further effort is required, using a control group and a larger sample, to provide a more definitive answer to the question addressed to this study. Additionally,

effort is needed to identify effective in-service techniques, methodologies, and content to assist elementary school teachers in improving their teaching of science.

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The Post-Embryonic Instars of a New Species of *Mydopholeus* (Acari:Astigmata:Rosensteiniidae)

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Abstract—A new species of Rosensteiniidae, *Mydopholeus wrenni*, is established based on specimens collected from bat guano in an Oklahoma cave. All post-embryonic instars are described. The genus *Guanophagoides* Fain and Flechtmann is synonymized with *Mydopholeus* McDaniel and Baker.

Introduction

In 1962 McDaniel and Baker described a new genus and species of Rosensteiniidae, *Mydopholeus capillus*, collected in Jalisco, Mexico. The present paper describes a new species of this genus which was collected in Oklahoma, U.S.A.

Mydopholeus wrenni new species

Relative positions of setae and other structures as indicated in figures. All measurements in micrometers with the mean given first and followed by the range in parentheses.

Description of Female (Figs. 1-2) (n = 6). Idiosomal length 367 (324-401); width at level of seta *sh* 271 (246-306). Idiosoma oval in outline, broadest anteriorly and narrowing posteriorly. Propodosoma and hysterosoma not divided by sejugal furrow. Dorsal surface striated with the exception of propodosomal region anterior to setae *sc e* (propodosomal shield), and the region anterior to and surrounding setae d_3 and extending to setae d_5 (on some specimens, a few striations occur between setae d_4 and d_5). Striations extending to ventral surface posterior to legs IV. Dorsum with 15 pairs of setae: *v i* 29 (24-32), *v e* 10 (8-12), *sc e* 82 (70-92), *sc i* 8 (4-10), *h* 46 (40-49), l_1 54 (49-58), l_2 36 (29-47), l_3 25 (19-29), l_4 22 (16-25), l_5 392 (332-430), d_1 8 (5-10), d_2 17 (12-19), d_3 21 (19-24), d_4 11 (9-15), d_5 18 (17-20). With the exception of setae *v e, sc i, d_1* and l_5, all dorsal setae cylindrical with barbs (pectinations) along their lengths. Setae *v e, sc i,* and d_1 short and hairlike, and setae l_5 long and whiplike (barbs lacking on both d_2 setae of one specimen, both d_4 setae of one specimen, one d_4 seta of four specimens, and one d_5 seta of one specimen; setae *v e* occasionally bifurcate at tip). Supra-coxal setae absent. Opening of bursa copulatrix dorsal and located centrally between setae d_3 and d_4. Venter of idiosoma with 11 pairs of setae: *sh* 21 (18-23), cx_1 25 (19-30), cx_3 21 (15-25), cx_4 49 (38-52), g_1 10 (8-13), g_2 10 (7-13), a_1 12 (10-16), a_2 12 (10-14), a_3 13 (11-15), a_4 11 (9-13), and a_5 16 (13-19). All setae hairlike with the exception of *sh* which is somewhat stouter and a_5 which is pectinate (a_3 also

pectinate on two specimens). Apodemes of legs I fused to form a "V", the base of which is fused to the epigynum. Apodemes of legs II unite with epigynum. Oviporus a sharply pointed inverted "V" extending between coxal fields II and III. Genital acetabula small, narrow, and tapering toward tip. Anus a longitudinal slit with lobes on each side, and located on posterior margin of idiosoma.

Leg I (Figs. 3-4) with trochanter bearing a thin pectinate seta (*pR*). Femur I with a cylindriform seta (*vF*) bearing small barbs along its length. Genu I with a single solenidion (σ) and two cylindriform setae (*mG* and *cG*), bearing small barbs. Tibia with a long solenidion (ϕ) and two spinelike setae (*gT* and *hT*). Tarsus with twelve setae and three solenidia. Solenidion ω_1 arising dorsally about one fourth of the way up from the base, and solenidia ω_2 and ω_3 both arising from distal end of tarsus. Famulus (ε) small and inserted in a depression in front of ω_1. Seta *ba* a stout spine located in front of famulus. Setae *s, v* and *u* clawlike and located ventrally and distally. All other setae simple and filiform. Seta *p* absent. Leg II (Figs. 5-6) similar to leg I except tarsus with eleven setae (seta *aa* absent) and seta *u* located dorsally instead of ventrally. Leg III (Figs. 7-8) with maximal setal compliment except for absence of tarsal setae *e* and *p*. Setae *sR, nG* and *kT* cylindrical and barbed. Leg IV (Figs. 9-10) with maximal setal compliment except for absence of tarsal setae *e* and *p*. Setae *wF* and *kT* cylindrical and barbed. Legs I and II stouter than III and IV. Legs I, II and III of approximately the same length, but leg IV longer than others, primarily due to a long, slender tarsus.

Subcapitulum (Fig. 21) and chelicerae (Fig. 22) similar to that found in *M. Capillus*. Venter of subcapitulum with a pair of flattened, veined, almost round pseudorutellar processes. Dorsal subcapitular setae (*cd*) short, stout and blunt. A pair of canals run from the podocephalic region through the subcapitulum and appear to empty into the mouth or cibarium.

Description of Male (Figs. 11-12) (n = 5). Idiosomal length 367 (349-391); width at level of seta *sh* 242 (232-257). Similar in idiosomal shape, dorsal setal pattern and dorsal striation pattern to female. Fifteen pairs of dorsal setae: *v i* 22 (21-24), *v e* 8 (7-11), *sc e* 83 (57-91), *sc i* 6 (4-7), *h* 64 (57-85), l_1 68 (64-78), l_2 50 (38-63), l_3 30 (22-39), l_4 26 (21-28), l_5 367 (363-377), d_1 6 (6-7), d_2 17 (14-21), d_3 18 (15-21), d_4 9 (8-11) and d_5 21 (18-23). Setae similar in shape and pectinations to
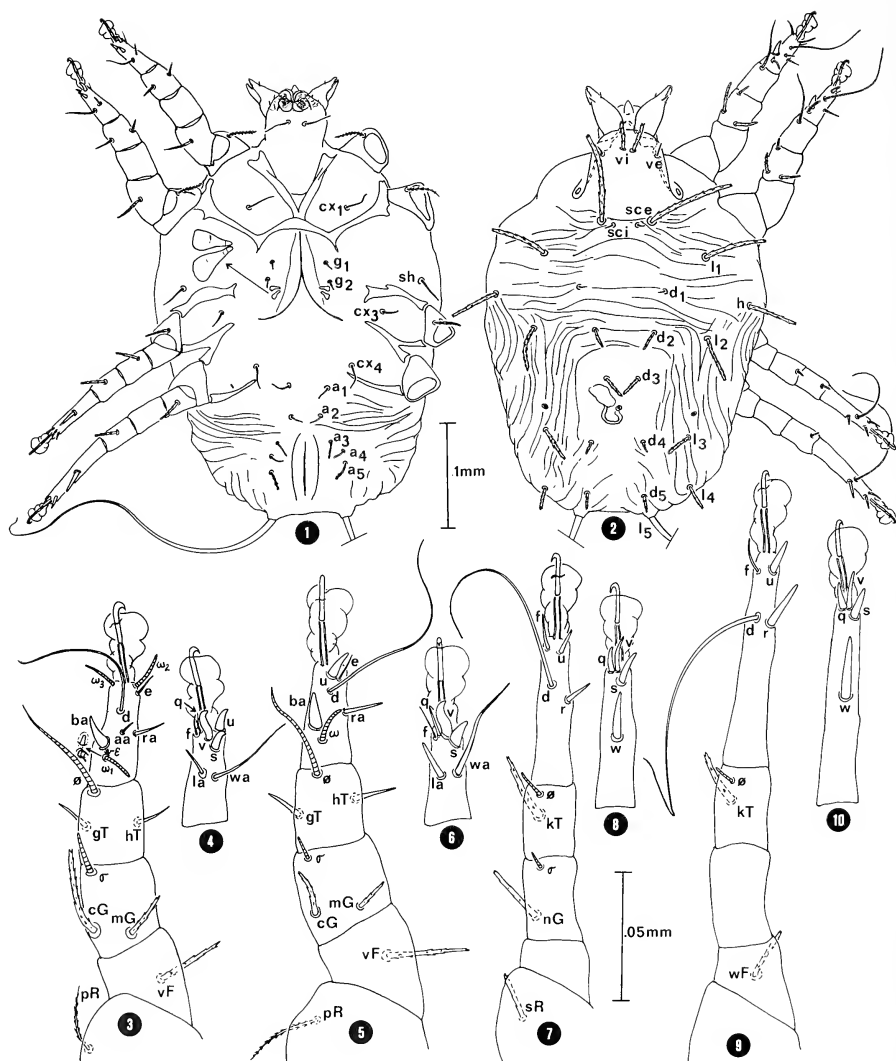
FIGS. 1-10. *Mydopholeus wrenni* female: 1) ventral view, 2) dorsal view, 3) leg I postaxial view, 4) tarsus I preaxial view, 5) leg II postaxial view, 6) tarsus II preaxial view, 7) leg III postaxial view, 8) tarsus III preaxial view, 9) leg IV postaxial view, 10) tarsus IV preaxial view.
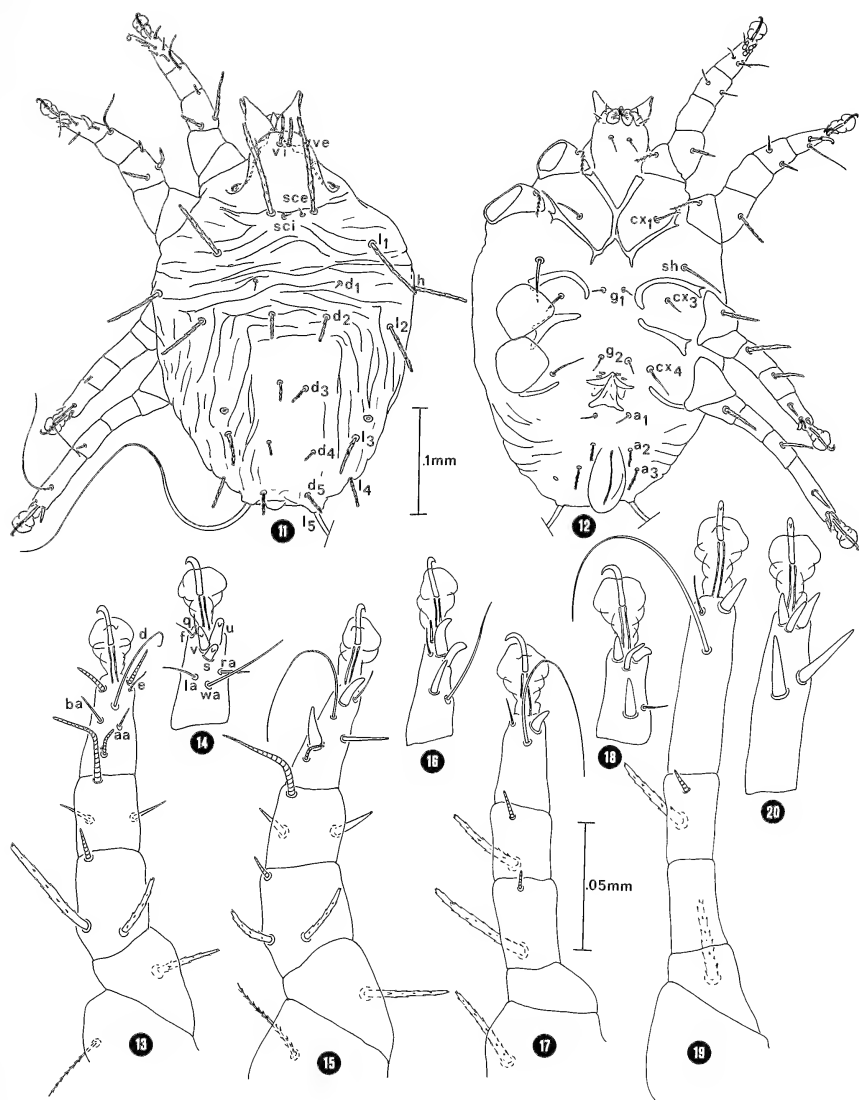
FIGS. 11-20. *Mydopholeus wrenni* male: 11) dorsal view, 12) ventral view, 13) leg I postaxial view, 14) tarsus I preaxial view, 15) leg II postaxial view, 16) tarsus II preaxial view, 17) leg III postaxial view, 18) tarsus III preaxial view, 19) leg IV postaxial view, 20) tarsus IV preaxial view.

those of female. Pectination of setae d_4 variable (three specimens with pectinations only at tip, and one specimen lacking pectinations). Chelicerae and subcapitulum similar to female.

Venter of idiosoma with nine pairs of setae: sh 44 (38-50), cx_1 34 (30-39), cx_3 24 (21-28), cx_4 61 (51-74), g_1 10 (9-13), g_2 11 (9-13), a_1 14 (11-16), a_2 17 (14-21) and a_3 17 (12-21). Coxal setae and setae sh spinelike, a_2 and a_3 thin and pectinate, and others hairlike (a_2 not pectinate on two specimens and a_3 not pectinate on one specimen). Apodemes of legs I fuse to form a "Y-shaped" sternum. Apodemes of legs II join at midline and are in turn fused to base of sternum. Genital apparatus between coxal fields IV. Genital acetabula and anus similar in appearance to female.

Legs (Figs. 13-20) similar in appearance to female except slightly stouter and with many setae being stouter and larger. Seta ba of tarsus I simple and filiform, not a stout spine as in female. Chaetotaxy and solenidiotaxy similar to female.

Description of Larva (Figs. 23-24) (n = 1). Idiosomal length 189; width at level of setae sh 154. Idiosoma ovoid, but cleft posterior to anus. Pattern of dorsal striations similar to adult, except longitudinal striations also present centrally at posterior of idiosoma. Dorsum bearing twelve pairs of setae: $v i$ 8, $v e$ 5, $sc e$ 21, $sc i$ 3, h 9, l_1 9, l_2 8, l_3 5, d_1 3, d_2 5, d_3 5 and d_4 5. Setae similar in appearance to female except d_2, d_3, d_4, l_2, l_3 and h not pectinate. Setae h with slight bifurcation at tip. Venter bearing four pairs of setae: sh 8, cx_1 12, cx_3 12 and a 6. Apodemes of legs I unite to form a "V-shaped" sternum; apodemes II and III free. Claparede organs absent from coxal fields I. Leg chaetotaxy and solenidiotaxy similar to female except trochanteral setae and tarsal solenidia ω_2 and ω_3 absent.

Description of Protonymph (Figs. 25-26) (n = 3). Idiosomal length 241 (200-265); width at level of seta sh 188 (159-203). Idiosoma ovoid with dorsal striations similar to larva. Dorsum bearing 15 pairs of setae: $v i$ 9 (7-12), $v e$ 6 (4-7), $sc e$ 43 (37-50), $sc i$ 4 (4-4), h 13 (13-18), l_1 25 (20-27), l_2 11 (9-13), l_3 7 (6-7), l_4 6 (6-7), l_5 148 (142-156), d_1 4 (4-5), d_2 5 (4-6), d_3 5 (4-6), d_4 4 (4-5) and d_5 5 (5-6). Setae similar in appearance to female with the exception that setae d_2, d_3, d_4, d_5, l_3 and l_4 not pectinate (both l_2 setae not pectinate on one specimen, and pectinate on only one of pair on two specimens; setae h with bifurcation at tip on two specimens). Venter bearing seven pairs of setae: sh 9 (6-12), cx_1 14 (11-18), cx_3 12 (9-14), g 7 (7-8), upper anal setae 7 (6-8), middle and lower anal setae 6 (5-6). No anal setae pectinate. Apodemes similar to larva except upper apodemes of leg IV fused at tip with lower apodemes of leg III. Legs I, II and III similar to female but with the absence of setae on trochanters and the absence of solenidion ω_3 on tarsus I. Leg IV without femoral setae, tibial setae, tibial solenidia and tarsal setae s and f. Genital primordia between coxal fields IV.

Description of Tritonymph (Figs. 27-28) (n = 10). Idiosomal length 322 (284-375); width at level of seta sh 249 (216-280). Idiosoma ovoid with dorsal striations similar to larva. Dorsum bearing 15 pairs of setae: $v i$

15 (14-18), $v e$ 6 (6-7), $sc e$ 62 (52-71), $sc i$ 4 (3-6), h 26 (20-36), l_1 40 (37-48), l_2 17 (12-23), l_3 12 (8-15), l_4 8 (6-13), l_5 279 (252-326), d_1 4 (3-6), d_2 6 (4-8), d_3 7 (5-8), d_4 6 (4-7) and d_5 6 (4-7). Setae similar in appearance to female with the exception that setae d_2, d_3, and d_4 and usually l_4 are not barbed (both setae l_4 barbed on one specimen, only one of pair barbed on one specimen, and both simply bifurcate at tip on one specimen; setae l_3 not barbed on two specimens and barbed on one seta of pair on one specimen). Venter bearing nine pairs of setae: sh 16 (13-22), cx_1 20 (16-25), cx_3 18 (14-22), cx_4 28 (22-43), upper genital setae 7 (7-8), lower genital setae 7 (7-8), upper anal setae 8 (7-9), middle anal setae 8 (6-9) and lower anal setae 7 (6-8). No anal setae pectinate. Apodemes similar to protonymph. Genital primordia between coxal fields IV. Leg chaetotaxy and solenidiotaxy similar to female.

Systematic Position. McDaniel and Baker (1962) described the genus *Mydopholeus* based on a single species (*M. capillus*) collected from the Mexican freetail bat *Tadarida brasiliensis* (Saussure) near Tamazula, Jalisco, Mexico. *Mydopholeus wrenni* shares with *M. Capillus* the following adult characteristics diagnostic of the genus. Tarsal seta ba a strong spine on legs I and II of the female and legs II of the male. Only one solenidion present on genu I. The dorsum of the idiosoma is striated in a characteristic pattern of transverse striations anteriorly and medially and longitudinal and oblique striations laterally. Fifteen pairs of dorsal setae present. The apodemes of legs I and II are fused—apodemes I forming a "V" and apodemes II a "W". Female with a dorsal bursa copulatrix, and the venter of the subcapitulum of both sexes bears a pair of almost circular pseudorutellar processes.

Mydopholeus wrenni differs from *M. capillus* in that dorsal setae d_1 are extremely short, dorsal setae $v e$, $sc i$ and d_1 are not pectinate, some anal setae are pectinate, and supra-coxal setae are lacking.

In 1978 Fain and Flechtmann established a new genus of Rosensteiniidae, *Guanophagoides*, based on a single species (*G. piracicabensis* Fain and Flechtmann) collected from bat guano in Piracicaba, Brazil. Their generic description is, however, consistent with that for *Mydopholeus* in the diagnostic characteristics cited above. Thus I consider *Guanophagoides* a junior synonym of *Mydopholeus* (NEW SYNONOMY). *Mydopholeus wrenni* differs from *M. piracicabensis* (NEW COMBINATION) in that dorsal setae d_1 are short, dorsal setae $v e$, $sc i$ and d_1 are not pectinate, the area around setae d_3 and d_4 is free of striations, some anal setae are pectinate, and setae $sc e$ are much shorter (setae $sc e$ are 10 to 20 times longer than $sc i$ in *M. wrenni*, and only four times longer in *M. piracicabensis*).

Habitat, Collection Locality, and Location of Types. *Mydopholeus wrenni* was extracted from bat guano collected in Merihew Cave on Old Merihew Ranch; located six miles south, two miles west of Aetna, Woods Co., Oklahoma. Almost all of the bat guano present in Merihew Cave is the product of Mexican freetail bats (*T. brasiliensis*).
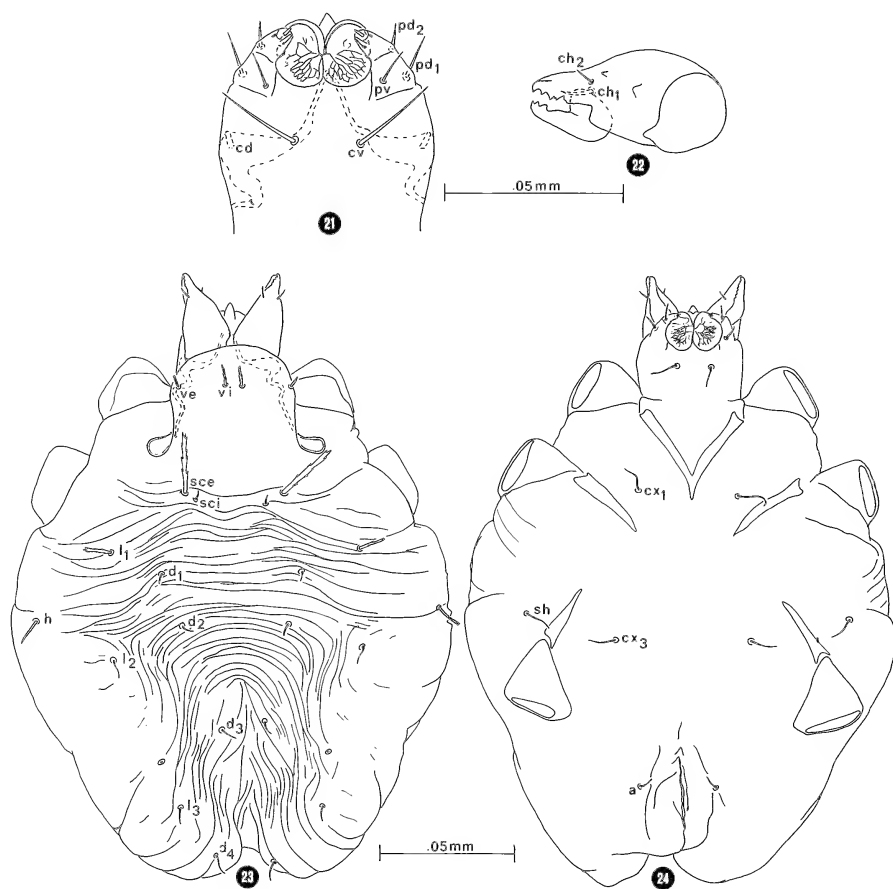
FIGS. 21-24. *Mydopholeus wrenni:* 21) female subcapitulum, ventral view, 22) female chelicera, 23) larva, dorsal view, 24) larva, ventral view.
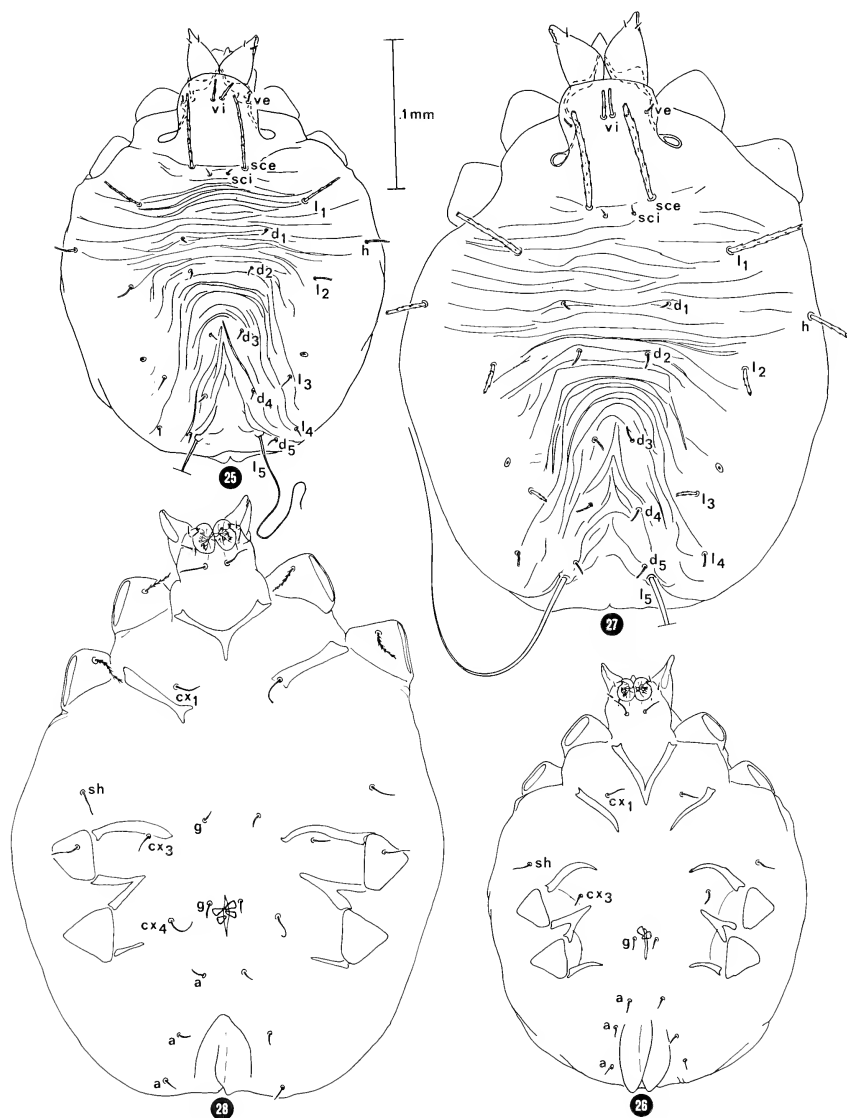
FIGS 25-28. *Mydopholeus wrenni:* 25) protonymph, dorsal view, 26) protonymph, ventral view, 27) tritonymph, dorsal view, 28) tritonymph, ventral view.

The holotype (female) will be deposited in the National Museum of Natural History, Washington, D.C., along with paratypes. Paratypes will also be deposited in the Acarology Laboratory, Ohio State University, Columbus, Ohio, and the Laboratoire de Zoologie Médicale, Institue de Médecine Tropicale, Anvers, Belgium.

Acknowledgements

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The Species of Rhododendron Native to North America[1]

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Abstract—The evergreen and deciduous species of *Rhododendron* native to North America are widespread throughout the area but do not occur in the Great Plains, Interior Plains, and Mexico. The highest species concentration is in eastern North America and centers in Virginia and North Carolina. Descriptions and keys of the species are provided.

Introduction

The Rhododendrons of North America are representatives of an old group of plants with floral parts typical of primitive angiosperms. Members of the genus existed in North America fifty million years ago in essentially the same form as those found today in the wild in Asia (Leach, 1961). According to Cronquist (1968), the family Ericaceae and order Ericales, to which the genus *Rhododendron* L. belongs, are found in the subclass Dilleniidae, one of four subclasses probably derived directly from the Theales and indirectly through the Theales from the Dilleniales, the order in the subclass most closely related to the Magnoliales of the Magnoliidae. The name *Rhododendron* is derived from the Greek words *rhodon* (rose) and *dendron* (tree) and was used by Pliny to describe the oleander *(Nerium oleander L.)*. It took on its present meaning when Linnaeus (1754) established the genus *Rhododendron.* As it is known today, the genus consists of about 1000 species that vary from tiny mats two inches high to giant trees (Leach, 1961). Ninety percent of the world's Rhododendrons are concentrated in southeastern Asia from the northwestern Himalayas, Tibet, western and central China, southward to Malesia and the Philippine Islands.

In North America, the twenty-seven native species occur in the arcticalpine areas of Canada and Alaska, along the Sierra Nevada and Cascade Ranges as far south as southern California and along the Rocky Mountains into Colorado. They are not found in the Great Plains, Interior Plains or in Mexico but appear again in the Ouachita belt in Missouri, Oklahoma and Arkansas, the Interior Plateau from Tennessee north into New York, the Coastal Plain from southeastern Texas through the Mississippi Embayment and north into New England and Piedmont. The highest concentration of species is in eastern North America and

centers in Virginia and North Carolina. The narrowest endemic, *R. vaseyi* A. Gray, is restricted to the higher mountains of western North Carolina at altitudes between 3000 and 5500 feet. The native Rhododendrons are mainly inhabitants of the temperate deciduous forests and most are found on the wooded acidic slopes of hills and mountains, although *R. roseum* (Loisel.) Rehd. and *R. oblongifolium* (Small) Millais do grow on limestone soil. The separation of the North American and Asiatic species has been attributed to continental drift and/or land bridges that have recently subsided. In North America the separation of the western and eastern species probably is due to the formation of mountain ranges during the late Tertiary and the glacial period (Lee, 1965).

The data in this paper have been compiled from field observations and collections, herbarium specimens, and literature (Duncan & Pullen, 1962; Funk & Fuller, 1978; Hulten, 1968; Hitchcock et al., 1969; Munz, 1963; Peck, 1961; Read & Wrzesinski, 1978; Rehder, 1927; Roane, 1975; Rydberg, 1922; Shiskin & Bobrov, 1967; Small, 1914, 1933; Solymosy, 1976; Viereck & Little, 1972; Wilson & Rehder, 1921; Wood, 1961).

Rhododendron Linnaeus

Evergreen or deciduous shrubs with alternate, entire or ciliateserrulate, glabrous to tomentose, lepidote or strigose leaves. Buds with several to many imbricate scales. Flowers 5-merous, usually in terminal corymbs. Calyx 5-parted, often very small, persistent. Corolla white to yellow or orange, pink, purple or deep red, rotate to companulate, or funnelform, usually irregular, with a 5-lobed limb, the median lobe adaxial; deciduous. Stamens 5-10, usually exserted from the corolla. Ovary superior, 5-locular. Fruit, a septicidal 5-loculed capsule, usually ovoid to oblong, 0.5-1 cm or more long.

Footnote

Key to Flowering Plants

1. Leaves evergreen, glabrous, lepidote or
   tomentose, not ciliate   2
1. Leaves deciduous, pubescent, often stri-
   gose and ciliate, never lepidote   8
   2(1). Plants lepidote   3
   2(1). Plants not lepidote   6
3(2). Flowers 2.5-5 cm across, corolla campanu-
   late-funnelform, erect shrubs   4
3(2). Flowers 1-2 cm across, corolla rotate-
   campanulate; procumbent, depressed or
   suberect-depressed shrub
                         1. *R. lapponicum*
      4(3). Flowers opening after the leafy
         shoots of the season expanded
                         4. *R. minus*
      4(3). Flowers opening before or with
         the expanding leafy shoots of the
         season   5
5(4). Tubes magenta, lobes rose with magenta
   spots on largest lobe; filaments white;
   anthers magenta
                         2. *R. chapmanii*
5(4). Tubes and lobes pale rose-purple; rarely
   white, usually not spotted; filaments pale
   pink; anthers pale yellow
                         3. *R. carolinianum*
      6(2). Calyx lobes much shorter than
         ovary, underside of leaves glabrous   7
      6(2). Calyx lobes as long as ovary,
         underside of leaves tomentose or
         pubescent
                         5. *R. maximum*
7(6). Pedicels glabrous, corolla rosy-purple with
   red-brown spots
                         6. *R. macrophyllum*
7(6). Pedicels pubescent, corolla lilac-purple
   with olive-green spots
                         7. *R. catawbiense*
      8(1). Stamens 10, in one case, 5-7; corolla
         rotate to rotate-campanulate,
         sometime two-lipped   9
      8(1). Stamens 5, corolla funnelform,
         subregular   12
9(8). Inflorescences axillary or lateral; corolla
   rotate-campanulate, not two-lipped, not
   divided to the base
                         8. *R. albiflorum*
9(8). Inflorescences terminal; corolla irregular,
   two-lipped or divided to the base on the
   lower side   10
      10(9). Procumbent shrubs, flowers soli-
         tary or two together
                         9. *R. camtschaticum*
      10(9). Erect shrubs, inflorescences with
         three or more flowers   11
      11(10). Stamens 10; corolla two-lipped
         with two lower lobes divided to the
         base, rose-purple, not spotted

                         10. *R. canadense*
      11(10). Stamens 5-7; corolla with short
         tube, slightly two-lipped, pink or
         white, with orange or red-orange
         spots
                         11. *R. vaseyi*
      12(8). Flowers yellow or orange to scar-
         let or red, rarely white or pink;
         corolla slightly subirregular with
         the uppermost lobe the largest;
         often with a conspicuous yellow or
         orange blotch on the largest lobe   13
      12(8). Flowers white to deep pink, car-
         mine or crimson; corolla regular;
         usually with no conspicuous blotch   18
13(12). Corolla abruptly dilated, tube longer than
   lobes   14
13(12). Corolla gradually dilated, tube as long as
   lobes   15
      14(13). Flowers opening before leaves
         expand; tube glandular, purple or
         red; lobes yellow
                         12. *R. austrinum*
      14(13). Flowers opening with the leaves,
         tube glandless, tube and lobes uni-
         colored, red to scarlet
                         15. *R. flammeum*
15(13). Corolla white or pink, style and filaments
   white
                         14. *R. occidentale*
15(13). Corolla yellow, orange, scarlet or red;
   style and filaments not white   16
      16(15). Filaments twice as long as tube,
         tube strongly ridged, calyx lobes
         cilate   13. *R. bakeri*
      16(15). Filaments three times as long as
         tube, tube not strongly ridged,
         calyx lobes glandular-ciliate   17
17(16). Corolla 5 cm or more across, style and
   filaments yellow to orange, flowers open-
   ing with the leaves
                         16. *R. calendulaceum*
17(16). Corolla 3.5-4 cm across, style and fila-
   ments brick red, flowers opening when
   leaves are about fully developed
                         17. *R. cumberlandense*
      18(12). Corolla without prominent rows
         of glands along large veins of lobes   19
      18(12). Corolla with prominent rows of
         glands along large veins of lobes   22
19(18). Winter buds glabrous   20
19(18). Winter buds pubescent   21
      20(19). Leaves glabrous; corolla tube pink,
         about as long as the lobes; fila-
         ments almost three times as long
         as tube; flowers not fragrant
                         19. *R. nudiflorum*
      20(19). Leaves pubescent beneath; corolla
         tube white, longer than lobes, fil-
         aments twice as long as tube; flow-
         ers fragrant

20. *R. alabamense*

21(19). Filaments twice as long as corolla tube; lobes about as long as tube; entire corolla usually bright pink, rarely white; with clove-pink fragrance
21. *R. roseum*

21(19). Filaments almost three times as long as corolla tube; lobes half as long as tube; tube usually deeper pink than lobes; flowers fragrant but not like clove-pink
22. *R. canescens*

22(18). Low, stoloniferous shrubs with simple or little-branched stems usually less than 0.5 m tall; leaf blades and petioles with short, stipitate glands
18. *R. atlanticum*

22(18). Much branched shrubs usually more than 0.5 m tall; leaf blades and petioles glandless   23

23(22). Branchlets pubescent; style pubescent   24
23(22). Branchlets glabrous; style glabrous   26

24(23). Leaves 4-10 cm long; calyx lobes oblong to oblong-lanceolate, unequal, 1-3 mm long
23. *R. oblongifolium*

24(23). Leaves 2-6 cm long; calyx lobes semi-orbicular to ovate, short, equal, 1 mm long   25

25(24). Branchlets yellow or gray-brown, hirsute or moderately strigose; corolla slightly pubescent inside above the middle
24. *R. viscosum*

25(24). Branchlets bright red-brown, copiously strigose, finely villous; corolla tube glabrous inside
25. *R. serrulatum*

26(23). Corolla white or pink; tube glandular-pilose outside; flowers fragrant;
26. *R. arborescens*

26(23). Corolla crimson; tube glabrous outside; flowers not fragrant
27. *R. prunifolium*

Key to Plants with Leaves and Capsules

1. Leaves evergreen, glabrous, lepidote, or tomentose, not ciliate   2
1. Leaves deciduous, glabrous, or pubescent, often strigose and ciliate, never lepidote 8
   2(1). Leaves lepidote   3
   2(1). Leaves glabrous   6
3(2). Shrubs erect, capsules to 12 mm long 4
3(2). Shrubs procumbent, depressed or suberect-depressed; capsules 4-5 mm long
1. *R. lapponicum*
   4(3). Leaves up to 13 cm long, blades acute or acuminate   5
   4(3). Leaves 2-5 cm long, blades obtuse or retuse

2. *R. chapmanii*

5(4). Low compact shrubs to 2 m; leaves elliptic to narrow-elliptic, somewhat broadened upward, 5-8 cm long; capsules oblong-ovoid, 8-12 mm long
3. *R. carolinianum*

5(4). Straggling shrubs to 3 m; leaves narrow-elliptic to lanceolate, not broadened upward, 4-10 cm long; capsules oblong, less than 8 mm long
4. *R. minus*

6(2). Pedicels glandular or pubescent   7
6(2). Pedicels glabrous
6. *R. macrophyllum*

7(6). Capsules and pedicels glandular
5. *R. maximum*

7(6). Capsules and pedicels pubescent
7. *R. catawbiense*

8(1). Twigs glabrous; leaves glabrous or sparingly strigose on lower midrib 9
8(1). Twigs pubescent and/or strigose; leaves pubescent, more or less strigose, sometimes stipitate-glandular 10

9(8). Capsules densely glandular
26. *R. arborescens*

9(8). Capsules strigose, minutely pubescent
27. *R. prunifolium*

10(8). Capsules axillary
8. *R. albiflorum*

10(8). Capsules terminal   11

11(10). Plants to 35 cm tall, capsule to 1 cm long; pedicels to 3 cm long
9. *R. camtschaticum*

11(10). Plants to 1 m or more tall; capsule length to 1.5 cm or more; pedicel length 2 cm or less   12

12(11). Capsules glandular   13
12(11). Capsules without glands   23
13(12). Leaves usually glandular   14
13(12). Leaves usually eglandular   17

14(12). Petioles usually glabrous, eglandular
11. *R. vaseyi*

14(12). Petioles usually pubescent, stipitate-glandular   15

15(14). Buds glabrous; shrubs stoloniferous, to 0.5 m tall
15. *R. atlanticum*

15(14). Buds pubescent; shrubs not stoloniferous, more than 0.5 m tall   16

16(15). Buds pink, twigs yellow-red or pink, shrubs to 1 m tall
10. *R. canadense*

16(15). Buds gray, twigs red-brown, shrub to 3 m tall
12. *R. austrinum*

17(13). Buds usually glabrous   18
17(13). Buds usually trichomatous   21

18(17). Twigs strigose, not pubescent; shrubs stoloniferous   19

18(17). Twigs strigose and pubescent; shrubs not stoloniferous   20

19(18). Leaves trichomatous; petioles villous and strigillose
        20. *R. alabamense*

19(18). Leaves glabrous; petioles strigillose, not villous
        24. *R. viscosum*

  20(18). Petioles pubescent; capsule strigose, glandular; buds yellow with no brown margin
        13. *R. bakeri*

  20(18). Petioles strigose; capsules villous, glandular-setose; buds yellow-brown with sharply marked dark brown marginal band
        25. *R. serrulatum*

21(17). Petioles pubescent; pedicels pubescent, eglandular
        23. *R. oblongifolium*

21(17). Petioles strigose, pubescent; pedicels pubescent, glandular   22

  22(21). Bud scales acuminate, aristate-mucronate, finely pubescent; leaves thinly pubescent on both surfaces
        14. *R. occidentale*

  22(21). Bud scales mucronulate, densely gray pubescent; leaves sparingly pubescent above and densely gray villous beneath
        21. *R. roseum*

23(12). Buds gray, densely pubescent
        22. *R. canescens*

23(12). Buds not gray, glabrous   24

  24(23). Leaves pubescent, strigose; pedicels eglandular, strigose   25

  24(23). Leaves pubescent, not strigose; pedicels setulose, stipitate-glandular
        16. *R. calendulaceum*

25(24). Capsules strigose, finely pubescent; leaves strigillose
        19. *R. nudiflorum*

25(24). Capsules strigose, not pubescent; leaves strigose, pubescent   26

  26(25). Pedicels strigose, pubescent; twigs yellow-brown, sparingly strigose or glabrous
        17. *R. cumberlandense*

  26(25). Pedicels strigose, not pubescent; twigs orange-brown densely strigose, finely pubescent
        15. *R. flammeum*

1. *Rhododendron lapponicum* (L.) Wahl. Fl. Suec. p. 249. 1824.
   Azalea lapponica L. Sp. Pl. 1:151. 1753.
Lapland Rose Bay. Alpine Rhododendron.

Matted to erect much branched shrub 1-4 cm tall. Twigs stout, brown, densely lepidote. Bud scales rosy purple, densely lepidote. Bud scales rosy purple, densely lepidote, mucronate, white ciliolate. Leaves oblong, elliptic or oval, to 1.5 cm long, obtuse, leathery, slightly revolute, densely lepidote, slightly paler beneath than above. Petioles lepidote, 0.5-1 mm long. Flowers in clusters of 1 to several, pink to deep purple, sometimes white, fragrant. Pedicels lepidote, 6-12 mm long. Calyx lobes minute, ovate to oblong-ovate, lepidote, long-ciliate. Corolla rotate-campanulate, 1.5-2 cm dia, 7-10 mm long, slightly hairy at base within, with rather deeply cut oblong lobes. Stamens 5-8(-10), much exserted; filaments pink to purple, gently curved, hairy only at the base, 1-1.5 cm long; anthers short, cylindric, ochraceous, 1 mm long. Style pink to purple, gently curved, slightly exceeding stamens. Capsules ovoid or ovoid-oblong, lepidote, rusty, to 7 mm long.

Occasional to rare shrubs of tundra and open spruce forests at tree line. Circumboreal in North America from Greenland, Labrador, Baffin Island, Ellesmere Island, Canadian Arctic, the mountains of south central Alaska west to the Arctic coast and north slope of Brooks Range. Absent from the northern coastal plain of Alaska. Also disjunct locations in the Gaspé, Maine, Wisconsin and the mountains of New York, New England. June to August.

2. *Rhododendron chapmanii* A. Gray. Proc. Acad. Phila. 11. 4;61. 1877.
   Azalea chapmanii (A. Gray) Kuntze. Rev. Gen. Pl. 2:387. 1891.
   Rhododendron minus Michx. var. *chapmanii* (A. Gray) Duncan & Pullen. Brittonia 14:297. 1962.

Evergreen shrubs usually 1 m tall, rarely to 2 m, with erect rigid branches. Twigs gray-yellow, rusty-lepidote. Buds gray-orange with rusty-lepidote, white-ciliolate, mucronate, obovate scales. Leaves coriaceous, revolute, oblong to oval, 2-5 cm long, obtuse or retuse at apex, abruptly narrowed at base, somewhat lustrous above, lepidote beneath. Petioles short, to 3 mm long, lepidote. Flowers several, in an umbel-like cluster, appearing before leafy shoots of the season, tubes magenta, lobes rose with magenta spots on largest lobe, not fragrant. Pedicels densely lepidote, 0.5-1 cm long. Calyx lobes broadly deltoid, less than 1 mm long, densely lepidote with long delicately white-ciliolate margin. Corolla 2.5-3 cm long, 3 cm dia, funnelform-campanulate; tube to 1 cm long and 5 mm wide; lobes oblong-ovate, to 1 cm long. Stamens 10; filaments white, more than 2.5 cm long; anthers magenta, less than 2.5 mm long. Style magenta, shorter than stamens. Capsules brown, densely lepidote, cylindric, to 1 cm long.

Low pinelands of western Florida. Late March.

3. *Rhododendron carolinianum* Rehder. Rhodora 14:99. 1912.
   Rhododendron punctatum Small, Fl. S.E. U.S. p. 884. 1903. (non Andrews)
   Rhododendron carolinianum var. *margarettae* Ashe. Rhodora 23:177. 1921.
   Rhododendron carolinianum var. *album* (Rehder) Rehder. Jour. Arnold Arb. 4:250. 1923.

Rhododendron carolinianum var. *foliatum* Rehder.
Jour. Arnold Arb. 7:33. 1926.

Rhododendron minus Michx. var. *minus* Duncan &
Pullen. Brittonia 14:297. 1962.

Low compact shrubs with thick branches. Twigs
green- or purple-lepidote. Buds ovoid, acute, with
broadly ovate, mucronate, densely white-ciliolate, lep-
idote scales. Leaves coriaceous, oval or elliptic to
elliptic-oblong, broadly cuneate at the base, acute or
shortly acuminate at the apex, 5-8 cm long and 2.5-4
cm broad, above at first lepidote but soon becoming
glabrous, somewhat lustrous, deep yellow-green, paler
beneath and densely, or sometimes more sparsely, lep-
idote, slightly revolute at the margin; midrib above
slightly, beneath strongly elevated. Petioles stout, rela-
tively long, lepidote, slightly pubescent, 0.5-1.5 cm
long. Flowers 4-9 in dense umbel-like terminal racemes,
pale rose-purple, rarely white, usually not spotted,
opening when young shoots are scarcely developed,
not fragrant. Pedicels 1-1.5 cm long, lepidote. Calyx
lobes semi-orbicular or broadly ovate, 2-3 mm long,
lepidote on margin and outside. Corolla rotate-
campanulate, 2.5 cm long and 3.5-4 cm wide, glabrous
or sparingly lepidote outside; lobes broadly ovate,
about as long or slightly longer than the short gradu-
ally widened tube. Stamens 10, slightly shorter than
the corolla; filaments pale pink, villous at base, 1-2.5
cm long; anthers pale yellow, 2-3 mm long. Style gla-
brous, purple, slightly shorter than stamens. Capsules
narrow-oblong, 8-12 mm long, 2-4 mm thick, brown,
lepidote.

In full bloom in early May when buds of *R. minus*
are still tightly closed. Higher mountains of North
Carolina, South Carolina, and Tennessee.

4. *Rhododendron minus* Michx. Jour. Hist. Nat. 1:412.
1792.

Rhododendron punctatum Andr. Bot. Reposit. 36.
1798.

Rhododendron parviflorum Hort. ex DC. Prodr. 7:723.
1839.

Azalea minor (Michx.) Kuntze. Rev. Gen. Pl. 2:386.
1891.

Branching, straggling evergreen shrubs 2-3.5 m tall.
Twigs sparingly lepidote, villous. Buds densely lepi-
dote with mucronate, white-ciliolate scales. Leaves
deep green and glabrous above, paler green, densely
lepidote and often glabrous beneath, mostly at the
ends of branches, narrow elliptic to lanceolate, 4-10 cm
long, acute or somewhat acuminate at both ends. Peti-
oles stout, more or less pubescent, lepidote, 3-12 mm
long. Flowers opening after leaves have unfolded, in
clusters of 7-10, clear rose spotted with green, some-
times white, rarely with yellow blotch on upper lobe,
not fragrant. Pedicels densely lepidote, to 1.5 cm long.
Calyx lobes lepidote, deltoid, delicately long-ciliate,
broader than long, to 2 mm long. Corolla funnelform-
campanulate, 2-3 cm long, 2-3 cm dia, lobes usually
flat but rarely crisped. Stamens 10, unequal; longer
filaments exceed 2.5 cm; anthers ochraceous, 2.5 mm

long. Style purple, 2-2.5 cm long. Capsules oblong or
oblong-ovoid, lepidote, 8-12 mm long.

Woodlands of inner Coastal Plain to lower Blue
Ridge of North Carolina to Georgia and Alabama.
Late May, June.

5. *Rhododendron maximum* L. Sp. Pl. 1;392. 1753.

Rhododendron purpureum G. Don. Gen. Hist. 3:843.
1834.

Rhododendron purshii G. Don. Gen. Hist. 3:843. 1834.

Rhododendron ashleyi Coker. Jour. Elisha Mitchell
Sci. Soc. 51:189. 1935.

Hymenanthes maxima (L.) Copeland. Amer. Mid-
land Nat. 30:614. 1943.

Rhododendron maximum var. *leachii* Harkness *in*
Leach, Rhododendrons of the World. p. 192. 1961.

Rose Bay. Great Laurel. White Laurel.

Evergreen shrubs or small trees to 10 m tall. Twigs
gray-brown, scurfy. Buds with red-brown, tomentose,
ciliate scales. Leaves thick, coriaceous, bright green
above, pale green beneath, oblong-obovate, 10-20 cm
long, abruptly narrowed or tapering at the base, gla-
brous above, almost imperceptibly scurfy beneath.
Petioles stout, scurfy, 2-4.5 cm long. Flowers opening
after the new leaves expand, numerous, in an umbel-
like cluster, white to rose, with yellow or orange spots,
somewhat green in throat, not fragrant. Pedicels
stipitate-glandular, 3-4 cm long. Calyx lobes ovate to
oblong, mostly longer than wide, 2-4 mm long. Corolla
rotate to campanulate, 2-3 cm long, 3.5-4 cm dia, lobes
not crisped. Stamens 10, unequal, the longer filaments
to 2 cm long, anthers 2 mm long. Style shorter than
stamens. Capsules stipitate-glandular, narrowly oblong
or cylindric-oblong or slightly narrowed upward, 1-1.5
cm long.

In woodlands, on northern slopes and shady
mountainsides, in sheltered stream valleys. Nova Sco-
tia to southern Ontario and Ohio, south, especially in
the mountains, to Georgia and Alabama. June, July.

6. *Rhododendron macrophyllum* G. Don. Gen. Hist. Pl.
3:843. 1834.

Rhododendron californicum Hook. Curtis' Bot.
Mag. 81: pl 4836. 1855.

Hymenanthes californica (Hooker) Copeland. Amer.
Midland Nat. 30:614. 1943.

Rhododendron macrophyllum f. *album* Rehder.
Jour. Arnold Arb. 28:254. 1947.

Hymenanthes macrophyllum (G. Don) Copeland.
Leaflet West. Bot. 5:140. 1948.

Hymenanthes macrophyllum f. *album* (Rehder)
Copeland. Leaflet West. Bot. 5:140. 1948.

Western Rose Bay. California Rose Bay.

Evergreen shrubs 1-5 m tall with coarse glabrous
branches. Twigs puberulent when young, then glabrate
and coarse. Buds glabrous with long-awned scales.
Leaves coriaceous, dark green above, paler and some-
what papillose beneath, oblong to elliptic, 6-20 cm
long. Petioles stout, glabrous, 1-2 cm long. Flowers
many, in terminal clusters, white to pink or rose-purple

with red-brown spots on upper lobes, not fragrant. Pedicels glabrous, 1.5-5 cm long. Calyx very shallowly lobed, glabrous, lobes 1 mm long and considerably broader, margin entire. Corolla tubular-campanulate, 2.5-4 cm long, glabrous, deeply 5-lobed, lobes ovate, spreading, crisped-undulate. Stamens 10, unequal, the longer ones well exserted; filaments white, sparsely short-trichomed on the lower half, 1-3.5 cm long; anthers pale yellow or pale pink, oblong, 2-3 mm long. Style pale pink or rose-purple, glabrous, as long as stamens. Ovary and young capsule strigose, stipitate-glandular. Mature capsules ovoid to oblong, woody, 1.5-2 cm long.

Dryish to damp, more or less shaded woods below 4000 feet from Vancouver Island and southern British Columbia along the coast of Washington and Oregon into northern California. April-July.

7. *Rhododendron catawbiense* Michx. Fl. Bor. Am. 1:258. 1803.

　　Hymenanthes catawbiensis (Michx.) Copeland. Amer. Midland Nat. 30:614. 1943.

Mountain Rose Bay. Purple Laurel. Rose Bay. Catawba Rhododendron.

Evergreen shrubs or small trees to 6 m tall. Twigs gray to red-brown, scurfy. Bud scales red-brown, slightly scurfy, glandular-ciliate. Leaves thick, coriaceous, dark green above, pale green beneath, oval or elliptic, 5-15 cm long, broadest near the middle, rounded, obtuse or subacute at both ends, sometimes subcordate at the base, abruptly pointed at apex, glabrous on both sides, aciliate, midribs sparingly hirsutulous. Petioles sparingly hirsutulous, stout, 1.5-2.5 cm long. Flowers many, in an umbel-like cluster, somewhat larger than those of *R. maximum,* rose-purple to lilac, rarely white, with olive-green spots on upper lobe, not fragrant. Pedicels 2.5-3.0 cm long, hirsutulous, eglandular. Calyx lobes broadly triangular or semicircular, broader than long, less than 1 mm long. Corolla rotate to campanulate, glabrous, to 6 cm dia. Stamens 10, to 3 mm long; filaments purple, anthers white, 2-3 mm long. Style about as long as stamens, purple. Capsules cylindric, 2-2.5 cm long, densely hirsute, eglandular.

Mountains of Virginia and West Virginia to Georgia and Alabama, rarely eastward to near the Coastal Plain. May, June.

8. *Rhododendron albiflorum* Hook. Fl. Bor. Am. 2:43. 1834.

　　Azalea albiflora Kuntze. Rev. Gen. 2:387. 1891.

　　Azaleastrum albiflorum (Hook.) Rydb. Mem. N.Y. Bot. Gard. 1:297. 1900.

Deciduous shrubs with erect branches, 1-2 m tall. Twigs finely puberulent, copiously red strigose-hirsute, glandular-strigose. Bud scales thin, caducous, strigose-hirsute. Leaves alternate, clustered or approximate on young shoots, thin, deep green above. lighter beneath, elliptic-oblanceolate, entire to undulate, 4-9 cm long, slightly ciliate, appressed-pilose and copiously strigose-hirsute, midribs appressed-villous. Petioles

pubescent, strigose, 5-10 mm long. Flowers white or ochroleucous with yellow spots, in axillary clusters of 1-4 along the stems, not fragrant. Pedicels stipitate-glandular, coarsely red-hirsute, 1-1.5 cm long. Calyx divided to base; lobes oblong, ovate or obovate, finely pubescent, red-hirsute, stipitate-glandular, ciliate, to 1 cm long. Corolla rotate or rotate-campanulate, 1-1.5 cm long, with very broad lobes about as long as the tube. Stamens 10, exserted, 1-1.5 cm long, with lower half of white filaments very pubescent, anthers obovoid or globoid, yellow, 1-2 mm long. Style white, pubescent at base, as long as filaments. Capsules ovoid, 6-10 mm long, heavy-walled, pubescent.

Wet places, usually along streams, chiefly montane. British Columbia south to Oregon and east to western Montana and Colorado. June through August.

9. *Rhododendron camtschaticum* Pall. Fl. Ross. I:48. 1784.

　　Rhododendron camtschaticus Lindl. Paxt. Fl. Gard. 1:pl 22. 1853.

　　Chamaecistus kamtschaticus Rgl. Dendrol. III:196. 1873.

　　Therorhodion cantschaticum (Pall.) Small. N. Amer. Fl. 29(1):45. 1914.

　　Therorhodion glandulosum Standley. N. Amer. Fl. 29(1):45. 1914.

　　Rhododendron kamtschaticum var. *pumilum* E. Busch. Fl. Sib. and Dal'm Vost. II:37. 1915.

　　Rhododendron kamtschaticum var. *pallasianum* Kom. Fl. Kamtsch. II:360. 1929.

　　Rhododendron kamtschaticum ssp. *typicum* Hult. Flora Kamtsch. IV:14. 1930.

　　Rhododendron kamtschaticum ssp. *glandulosum* (Standley) Hult. Flora Kamtsch. IV:14. 1930.

　　Rhododendron kamtschaticum ssp. *intercedens* Hult. Flora Kamtsch. IV:14. 1930.

Kamchatka Rhododendron.

Deciduous shrubs to 3 cm tall, with depressed stems, much branched, with leaves approximate in rosettes at ends of branches, spreading underground by means of suckers. Twigs gray-brown to red-brown, coarse, sparingly glandular-pilose, with long scattered trichomes. Buds yellow-brown, glabrous, scales thin, persistant, mucronate, strigose, ciliate. Leaves cuneate to obovate or oval, 1-4 cm long, obtuse or rounded, mucronulate at apex, bristly-ciliate, glandular-ciliate, sparingly pilose and strigose on veins beneath, sessile. Flowers opening with the leaves, rose-purple, with deeper rose-purple spots, very rarely white, 1-3, terminating leafy shoots, not fragrant. Pedicels 1 cm or more long, glandular-pilose with 2 foliaceous bracteoles. Calyx lobes oblong-oval, 1-2 cm long, glandular-pubescent, bristly-ciliate. Corolla rotate, 2.5-5 cm dia. glabrous to pubescent, deeply lobed; tube to 5 mm long; lobes erose, often ciliolate, two-lipped, lower lip deeply cleft, 2-2.5 cm long. Stamens 10, unequal; filaments purple, villous at base, shorter than corolla, lower 5 twice as long as upper 5; anthers oval or obovoid, purple. Style villous at base, exceeding stamens, purple. Capsule ovoid, thin-walled, villous, sub-

coriaceous, 5-10 mm long.

Dry rocky tundra of Aleutian Islands and alpine zone of forested regions of Alaska. June through August.

10. *Rhododendron canadense* (L.) Torr. Geol. Survey
    New York Assembly, No. 50. 1839. Cat. Pl. p. 151.
    Rhodora canadensis L. Sp. Pl. Ed. 2. 1:561. 1762.
    Hochenwartia canadensis Crantz. Inst. 1I:469. 1766.
    Rhododendron rhodora G. F. Gmelin. Syst. Nat. 11
    pt. 1:694. 1791.
    Rhodora congesta Moench. Meth.:68. 1794.
    Rhododendron pulchellum Salisb. Prodr.:287. 1796.
    Azalea canadensis (L.) O. Kuntze. Rev. Gen. 1I:386.
    1891.
    Rhodora.

Much branched deciduous shrubs to 1 m tall, with slender upright or ascending branches. Twigs puberulous, bright yellow-red or pink, often slightly bloomy. Buds finely pubescent with ovate, acuminate to acute, pink, ciliolate scales. Leaves elliptic to oblong, obtuse or acute, cuneate at base, 2-4.5 (-6) cm long; with ciliate and revolute margin; dull blue-green, somewhat strigillose, with finely villous midribs above; thinly gray-tomentulose, with scattered fulvous trichomes and short stipitate glands, sparingly strigose midribs beneath. Petioles puberulous, sparingly strigose, 2-5 mm long. Flowers opening before leaves in 3-7-flowered umbel-like racemes, rose-purple, not fragrant. Pedicels puberulous, glaucous, sparingly glandular-pilose, 3-7 mm long. Calyx lobes very short, unequal, puberulous, setosely-ciliate. Corolla glabrous, 1.5-2 cm long, two-lipped, the lower lip divided nearly to the base into two nearly distinct narrow-oblong lobes, the upper lip with three short ovate lobes. Stamens 10, unequal, about as long as corolla; filaments pubescent on lower third, purple; anthers broadly ellipsoidal, purple, 2 mm long. Style slightly longer than stamens, 1.5-2 cm long, glabrous or minutely pilose at base, purple. Capsules ovoid-oblong, curved near the base, slightly grooved, setose, finely puberulous, sparingly short stipitate-glandular, light red-brown with a pink bloom, 1-1.5 cm long.

River banks, moist woods and swamps from Labrador and Newfoundland to southwestern Quebec and south through New England, central New York to northeastern Pennsylvania and northern New Jersey. April-May; June in the north.

11. *Rhododendron vaseyi* A. Gray. Proc. Amer. Acad.
    XV:48. 1879.
    Azalea vaseyi (Gray) Rehder. Möller's Deutsch.
    Gärtn.-Zeit. XIV:332. 1899.
    Biltia vaseyi (Gray) Small. FL. S.E. U.S. p. 884.
    1903.
    Pinkshell Azalea.

Deciduous, upright, irregularly branched shrubs with spreading branches, to 5 m tall, not stoloniferous. Twigs light red-brown, puberulous, sparingly pilose, glabrescent. Buds with orbicular-ovate, mucronulate

scales, outer acuminate, glabrous, inner ones minutely puberulous, white-ciliate, sometimes glandular-ciliate. Leaves elliptic, elliptic-oblong, acuminate, cuneate, 5-12 cm long, 2-5 cm broad; margins ciliate, usually slightly undulate; glabrous above and sparingly short stipitate-glandular near midribs beneath; midribs sparingly finely-villous above and sparingly pilose beneath. Petioles glabrous or sparingly pilose, 3-7 mm long. Flowers opening before leaves, in 5-8 flowered racemes, white or light rose with orange or red-orange dots, not fragrant. Pedicels short stipitate-glandular, 0.5-1.5 cm long. Calyx oblique with shallow, rounded lobes erose-glandular on margins. Corolla rotate-campanulate, 2.5-3 cm long, two-lipped, glabrous; tube very short, to 5 mm long; lobes oblong, rounded at apex, upper lip less deeply divided, with middle lobe exterior in bud. Stamens usually 7, sometimes 5 or 6, unequal, the longer exceeding the corolla; filaments glabrous, white or pink; anthers ellipsoid, white, pink, or purple, 1-2 mm long. Style glabrous or with a few stipitate glands near the base, white, longer than stamens, 2.5-3 cm long. Capsules narrow-oblong, with thin narrow keel on back of valves, stipitate-glandular, 1-1.5 cm long.

Mountain slopes and summits. North Carolina. May.

12. *Rhododendron austrinum* (Small) Rehder *in* Bailey,
    Stand. Cycl. Hort. V1:3574. 1917.
    Rhododendron nudiflorum var. *luteum* Curtiss *in*
    Rehder, A Monograph of Azalea. p. 146. 1921.
    Azalea austrina Small. FL. S.E.U.S. Ed. 2. p. 1356.
    1913.
    Florida Azalea.

Deciduous shrubs to 3 m tall, with irregular branches, not observed to be stoloniferous. Twigs red-brown, with soft puberulence, sparingly strigose, copiously stipitate-glandular. Buds with ovate, acuminate scales, densely gray-pubescent. Leaves elliptic to obovate or oblong-ovate, 3-9 cm long, acute or obtuse and mucronulate at apex, cuneate at base, setosely ciliate or glandular-ciliate, finely pubescent on both sides but pubescence denser on lower. Petioles pubescent and stipitate-glandular, sparingly strigose, 3-8 mm long. Flowers opening before or with leaves, yellow to orange with no yellow to orange blotch, the tube more or less purple, slightly fragrant, in 8-15-flowered umbel-like racemes. Pedicels pubescent, glandular-setose, 0.5-1 cm long. Calyx lobes broadly ovate to oblong, unequal, 1-2.5 mm long, glandular-ciliate, pubescent. Corolla funnelform; tube 1.5-2 cm long, cylindric, abruptly dilated at apex, finely pubescent, stipitate-glandular; lobes 1-1.5 cm long, short-acuminate with recurved points, finely pubescent outside. Stamens three times as long as tube, filaments pubescent below the middle, anthers ochraceous, 2-3 mm long. Style slightly exceeding stamens, 5-6 cm long, short-pilose near base. Capsules oblong-cylindric, 1.5-2.5 cm long, with thin, fine pubescence, long-strigose, partly gland-tipped trichomes.

River banks and sometimes flood plains. Originally reported from Gadsden and Liberty Counties in Flor-

ida but also from Georgia, Alabama and Mississippi. Late April.

13. *Rhododendron bakeri* (Lemmon & McKay) Hume. Azaleas, Kinds and Culture. p. 28. 1949.
   Azalea bakeri Lemmon & McKay. Bartonia 19:16-17. 1938.

Deciduous shrubs or small trees regularly to 3 m tall, with irregularly whorled branches, not stoloniferous. Twigs light green, puberulent, sparingly strigose. Buds yellow, conical; scales glabrous, ciliate, mucronate or awned; awn shorter than body of scale. Leaves narrowly to broadly elliptic, acute, mucronulate,˙2-8 cm long, ciliate; blades glabrous or pubescent above, glabrous, shiny or pubescent beneath; midribs strigose above and pubescent and strigose beneath; veins strigillose beneath. Petioles pubescent, 2-5 mm long. Flowers in clusters of 3-9, expanding after leaves, yellow or red-orange with no distinct yellow to orange blotch, not fragrant. Pedicels villous, stipitate-glandular, 2-6 mm long. Calyx lobes unequal, elliptic-acuminate to deltoid-ovate, setose, ciliate. Corolla funnelform, 5-6 cm dia; tube strongly ridged, pubescent, stipitate-glandular, gradually dilated, 1.5-2.5 cm long; lobes ovate to elliptic, acute, slightly pubescent and stipitate-glandular, 1.5-2.5 cm long. Stamens 5, exserted; filaments more than twice the length of the tube with the exserted portion glabrous, carmine and the remainder pubescent, lighter; anthers ochraceous, 2 mm long. Style carmine, with pubescent base, 7.5 cm long. Capsules cylindric, strigose with appressed gland-tipped trichomes, 1.5 cm long.

Blue Ridge Mountains of Georgia and North Carolina above 3000 feet. June-August.

14. *Rhododendron occidentale* (Torr. & Gray) A. Gray. Bot. Calif. I:458. 1876.
   Azalea calendulacea Hooker & Arnott. Bot. Capt. Beechey Voy. 362. 1841. (not Michaux)
   Azalea nudiflora var. *ciliata* Kellogg. Proc. Calif. Acad. Sci. I:60. 1855.
   Azalea californica Torrey & Gray. Durand, Jour. Acad. Philadelphia. Ser. 3, III:94. 1855. (not *R. californicum* Hooker)
   Azalea occidentalis Torrey & Gray. Rev. Explor. Surv. Miss. Pacif. Ocean IV:116. 1856.
   Rhododendron sonomense Green. Pittonia II:172. 1891.
Western Azalea. Pacific Azalea.

Deciduous shrubs to 3 (-5) m tall with loose branching, shredding bark. Twigs stiff, divaricate, glabrous to pubescent, sometimes stipitate-glandular, brown. Buds finely pubescent or nearly glabrous with ovate to ovate-lanceolate, acuminate, aristate-mucronate or mucronulate scales. Leaves elliptic, oblong-lanceolate, 3-9 cm long, acute or obtuse, mucronulate, cuneate or attenuate at base, ciliate, thinly pubescent on both surfaces, rarely nearly glabrous; midribs pubescent above, sparingly strigose beneath. Petioles rather stout, short, pubescent, strigose, 1-5 mm long. Flowers opening with or after leaves, 5-20 in umbel-like

racemes, white to pink with yellow blotch, usually not fragrant. Pedicels pubescent, more or less glandular, sometimes pilose, eglandular, rarely nearly glabrous, to 1.5 cm long. Calyx lobes broadly ovate to oblong-ovate, obtuse, 1.5-5 mm long, densely ciliate with usually setose gland-tipped or glandless hairs. Corolla funnelform, somewhat irregular; tube narrowly funnelform, gradually dilated upward, villous, glandular-pilose, 2-3 cm long; lobes about as long as tube, broad-ovate, acute. Stamens 5, exserted, more than twice tube length; filaments pilose below middle, white; anthers white, 2.5-3 mm long. Style as long or longer than stamens, white, pubescent above base. Capsules ovate-oblong, setosely pilose, stipitate-glandular, 1-2 cm long.

Moist thickets and stream banks among the mountains to 5800 feet elev. Oregon, California. June, July; rarely as early as April or as late as mid-August.

15. *Rhododendron flammeum* (Michx.) Sargent. Rhododendron Soc. Notes 1(3):120. 1917.
   Azalea nudiflora coccinea Aiton. Hort. Kew. 1:202. 1789.
   Azalea coccinea Curtis. Bot. Mag. 5, t. 180. 1792.
   Azalea fulva Michaux. Jour. Hist. Nat. 1:410. 1792. (*nom. nud.*)
   Azalea calendulacea α *flammea* Michaux. Fl. Bor.-Am. I:151. 1803.
   Azalea speciosa Willdenow. Berl. Baumz. Ed. 2:49. 1811.
   Azalea periclymenoides var. *coccinea* Pursh. Fl. Am. Sept. I:152. 1814.
   Azalea nudiflora Loiseleur-Deslongchamps. Herb. Amat. IV:213, t. 1820. (not Linnaeus)
   Azalea coccinea major Loddiges. Bot. Cab. VII; t. 624. 1822.
   Azalea speciosa α *major* Sweet. Hort. Brit. p. 265. 1826.
   Rhododendron speciosum α *major* Sweet. Hort. Brit. Ed. 2 p. 343. 1830.
   Rhododendron nudiflorum ζ *coccineum* Sweet. Hort. Brit. Ed. 2. p. 343. 1830.
   Azalea speciosa α *coccinea* DeCandolle. Prodr. VII:717. 1839.
   Azalea calendulacea Darby. Bot. S. States p. 422. 1855. (in part)
   Rhododendron calendulaceum Chapman. Fl. S. U.S. p. 265. 1860. (in part)
   Rhododendron calendulaceum f. *speciosum* Voss. Vilmorin's Blumengart. I:588. 1894.
Oconee Azalea.

Deciduous shrubs to 2 m tall with slender, irregularly whorled branches, stoloniferous. Twigs finely pubescent, densely strigillose, trichomes rust-brown; branches orange-brown becoming gray to dark brown-gray, somewhat decorticating. Buds glabrous with scales ovate, mucronate, sometimes aristate, to 3 mm long, ciliolate. Leaves obovate, elliptic or oblong, acute or obtuse, mucronulate, broad-cuneate at base, 3-6 cm long, 1-2 (-3) cm broad; strigillose, sometimes glabrescent above, finely pubescent, densely pubescent

on veins, strigose on midribs beneath; setosely ciliate. Petioles pubescent, strigillose, 3-5 mm long. Flowers opening with the leaves in 6-15-flowered umbel-like racemes, scarlet or bright red with large orange blotch on upper lobe, not fragrant. Pedicels strigillose, eglandular, 6-12 mm long. Calyx lobes round-ovate to oblong, long-ciliate, pubescent or nearly glabrous, 0.5-3 mm long. Corolla funnelform, 3-5 cm dia; tube cylindric, rather slender, 2-2.5 cm long, longer than lobes, abruptly dilated at apex, villous, pilose, occasionally sparely stipitate-glandular; lobes ovate, abruptly acuminate, 1.5-2 cm long. Stamens 5, much exserted, more than twice as long as tube; filaments pubescent below middle, rose-pink; anthers ochraceous to yellow, to 2 mm long. Style slightly longer than stamens, finely pubescent on lower third, usually purple above. Capsules ovoid to narrow-oblong, narrowed toward apex, strigose, 2-3 cm long.

Dry open woods and sand hills. Piedmont of South Carolina, Georgia. Late April, early May.

16. *Rhododendron calendulaceum* (Michx.) Torr. Fl. U.S. p. 425. 1824.
    Azalea lutea L. Sp. Pl. 1:150. 1753. (in part)
    Azalea nudiflora L. Sp. Pl. Ed. 2. 1:214. 1762. (in part)
    Azalea flammea Bartram. Travels 1:327. 1791. (*nom. nud.*)
    Azalea calendulacea Michx. Fl. Bor. Am. I:151. 1803. (excluding var. α)
    Azalea aurantiaca Dietrich. Darst. Verz. Zierpfl. 4, t. 1. 1803.
    Azalea pontica β *A. calendulacea* Persoon. Syn. 1:212. 1805.
    Rhododendron luteum (L.) Schneider. Ill. Handb. Laubholzk. II:500, fig. 329 q-r, 320a. 1911. (not Sweet)
Flame Azalea. Yellow Azalea.

Deciduous shrubs 1.5-3 (-5) m tall, with erect and spreading branches, not observed to be stoloniferous. Twigs gray-brown, strigose with fine dense pubescence. Buds glabrous, brown with broadly ovate, apiculate, densely white-ciliolate scales. Leaves oblong to obovate or lanceolate, ciliate, 4-8 cm long, acute, mucronulate, broadly cuneate at base, finely pubescent above, densely pubescent beneath when young, particularly on and along the midribs. Petioles pubescent, 2-5 mm long. Flowers expanding with or shortly after the leaves, in clusters of 5-7, yellow or orange to scarlet, with orange blotch on upper lobe, not fragrant. Pedicels setulose, stipitate-glandular, 0.5-1 cm long. Calyx lobes oblong to ovate, obtuse, setulose, glandular-ciliate, 2-3 mm long. Corolla funnelform, over 6 cm dia; tube gradually dilated above the middle, 1.5-2 cm long, glandular-pilose and pubescent; lobes ovate, undulate, abruptly contracted into short points, slightly pubescent outside, 2 cm long, 1.5 cm broad. Stamens 5, nearly 3 times as long as tube; filaments yellow to orange, pubescent toward the base; anthers yellow to orange, 3 mm long. Style yellow to orange, pilose toward base, 6-7 cm long, as long or longer than

stamens. Capsules ovoid-oblong, 1.5-2 cm long, setose, pubescent.

Appalachian mountain region from Pennsylvania to northern Georgia in open woods and along streams. May-June.

17. *Rhododendron cumberlandense* Braun. Rhodora 43:33. 1941.
Red Azalea. Cumberland Azalea.

Deciduous compactly-growing shrub to 3 m tall but usually lower growing, sometimes stoloniferous. Twigs yellow-brown, sparsely strigose or glabrous. Buds glabrous, yellow-brown with ciliate, mucronate inner scales, outer scales with awn as long as body of scale. Leaves narrowly obovate, 3-5 cm long, less than half as wide, glabrous, full grown at anthesis; midribs strigose with fine white pubescence above, sparingly strigose, finely pubescent beneath. Petioles strigose, pubescent, 3-5 mm long. Flowers opening after leaves are expanded, several in a short raceme, orange-red to red with large orange blotch, not fragrant. Pedicels strigose, finely pubescent, 3-7 mm long. Calyx lobes round-ovate, sparsely hirsute, glandular-ciliate, less than 1 mm long. Corolla 3.5-4 (-5) cm dia, funnelform, pubescent, strigillose, with short almost sessile glands outside; tube 1-2 cm long, gradually dilated; upper lobe broader than laterals, sometimes twice as broad, almost orbicular but contracted to a short acuminate tip. Stamens 5, exserted; filaments brick red, nearly glabrous, 3 times as long as tube; anthers ochraceous, 1-2 mm long. Style brick red, glabrous, 6-7 cm long. Capsules ovoid, strigose, to 2 cm long.

Mesophytic oak woods. Cumberland and Kanawha Plateaus, Cumberland Mountains of Virginia, Kentucky, Tennessee. June.

18. *Rhododendron atlanticum* (Ashe) Rehder in Wilson & Rehder. A monograph of Azalea. p. 147. 1921.
    Azalea atlantica Ashe. Bull. Charleston Mus. XIII:26. 1917.
Dwarf Azalea. Coast Azalea.

Low, stoloniferous, deciduous shrubs rarely more than 0.5 m tall, with slender upright usually sparingly branched or simple stems. Twigs red-brown, glabrous to sparingly strigillose and sometimes setosely glandular. Buds light brown, glabrous or slightly silky pubescent; scales ovate, mucronulate, white-ciliolate. Leaves obovate to oblong-ovate, bright green or bluish-green, 3-6 cm long, setosely-ciliate, glabrous above except sometimes short stipitate-glandular, glabrous or short stipitate-glandular beneath; midribs villous above, sparingly strigose, sometimes pubescent, short stipitate-glandular beneath. Petioles sparingly strigillose, short stipitate-glandular, 1-5 mm long. Flowers opening before or with the leaves, white usually flushed pink or purple, no blotch present, in clusters of 4-10, very fragrant. Pedicels to 1 cm long, hirsute, stipitate-glandular. Calyx lobes broadly ovate, glandular-ciliate, 2-4 mm long. Corolla funnelform, 4 cm dia; tube cylindric, gradually dilated at apex, 2-2.5 cm long with

numerous short gland-tipped trichomes, otherwise glabrous or slightly villous; lobes ovate to ovate-oblong, acute 1.3-2 cm long, prominently stipitate-glandular along the middle. Stamens 5, twice as long as the tube, filaments white to pale buff, villous below middle, anthers white to pale buff, 2-3 mm long. Style exceeding stamens, 4.5-5.5 cm long, pubescent below the middle, purple above. Capsules ovoid-oblong, setose, stipitate-glandular, 1.5-2 cm long.

Coastal Plain pine barrens, Delaware to South Carolina. Late April, early May.

19. *Rhododendron nudiflorum* (L.) Torr. Fl. U.S. p. 424. 1824.
   Azalea lutea L. Sp. Pl. 1:150. 1753. (in part)
   Azalea nudiflora L. Sp. Pl. Ed. 2. 1:214. 1762. (in part)
   Rhododendron venustum Salisbury. Prodr. p. 287. 1796. (in part)
   Azalea periclymenoides Michaux. Fl.Bor.-Am. 1:151. 1803.
   Azalea periclymena Persoon. Syn. 1:212. 1805.
   Azalea nudiflora periclymenoides (Michx.) Heynhold. Nomencl. Bot. Hort. 1:108. 1840.
   Anthododendron nudiflorum (L.) Reichenbach *in* Moessler, Handb. Gewächsk. Ed. 2, 1:309. 1827.
   Rhododendron periclymenoides (Michx.) Shinners. Castanea 27: 95. 1962.
Wild Azalea. Early Azalea. Pinxterflower. Pinksterflower. Honeysuckle. Pinxterbloom Azalea.

Deciduous, upright shrubs, 1-2 (-3) m tall with irregularly whorled, intricate branching, occasionally stoloniferous. Twigs slightly pubescent, sparingly strigose. Buds glabrous or slightly pubescent, brown, with ovate, abruptly acuminate, finely ciliate scales. Leaves elliptic, oblong, obovate or oblong-obovate, acute or abruptly acuminulate, rarely obtuse, mucronate, finely ciliate, 3-8 cm long, 1.5-3 cm wide, glabrous except for finely pubescent midribs above, strigillose and sometimes pubescent midribs beneath. Petioles strigillose, sometimes slightly pubescent, 2-4 mm long. Flowers opening before or with expanding leaves in clusters of 6-12 or more, white to pink or pink-purple, without blotch, not fragrant. Pedicels strigose-pilose, sometimes finely pubescent, rarely sparingly stipitate-glandular, 4-6 mm long. Calyx lobes semi-orbicular or ovate, long-ciliate, 0.5-2 mm long. Corolla funnelform, 3.5-5 cm dia; tube gradually dilated above, finely pubescent, pilose or strigose-pilose, sometimes stipitate-glandular, 1.5-2 cm long; lobes ovate to oblong-ovate, abruptly acuminate, finely pubescent to glabrescent outside, 1.2-1.6 cm long. Stamens 5, nearly 3 times tube length; filaments pubescent below middle, white, 4-6 cm long; anthers yellow-brown or yellow-orange, 2-2.5 mm long. Style 5-6 cm long, exceeding stamens, finely pubescent on lower third, usually purple above. Capsules oblong to narrow-oblong, narrowed upward, finely pubescent, usually strigose, 1-2 cm long.

Moist or dry open woods, bogs, along mountain streams, chiefly in Appalachian Mountains to 3800 feet elev. but extending into Piedmont and Coastal Plain. Massachusetts to North Carolina, from the Atlantic coast west to central New York, Pennsylvania, southern Ohio, eastern Kentucky, also Calloway County in western Kentucky, eastern Tennessee. April, May.

20. *Rhododendron alabamense* Rehder in Wilson & Rehder. A monograph of Azalea. p. 141. 1921.
   Azalea nudiflora var. *alba* Mohr. Pl. Life Ala. p. 653. 1901. (not Pursh)

Low deciduous shrubs 1-1.5 m high, with irregularly whorled branches, stoloniferous. Twigs gray or yellow-brown, densely or sparingly strigose. Buds brown, glabrous, with ovate, mucronate, densely white-ciliate scales. Leaves obovate, elliptic to elliptic-oblong or obovate-oblong, base cuneate, apex mucronate, 3-6 cm long, 1-3 cm wide, finely strigillose and sparingly puberulous above, glaucescent or pale green and densely short-villous beneath; midribs villous above and sparingly strigose beneath. Petioles short, rarely over 5 mm long, villous, strigillose. Flowers opening with expanding leaves, in umbel-like racemes of 5-15, white, white with yellow blotch, shades of yellow, white with shades of pink and rose, pink, intensely fragrant. Pedicels villous, stipitate-glandular, rarely eglandular, to 1.5 cm long. Calyx lobes unequal, round to ovate, 0.5-1.5 mm long, densely setose, eglandular. Corolla funnelform with cylindric tube, gradually dilated at apex, 2-3 cm long, stipitate-glandular or hirsute outside; lobes ovate, acute, 1.5-2 cm long, distinctly shorter than tube, not undulate. Stamens 5, twice as long as tube; filaments white, villous on lower half; anthers yellow, 2-3 mm long. Style exceeding the stamens by 1 cm, finely villous at base, white. Capsules cylindric-oblong, finely villous, stipitate-glandular or eglandular and strigose, 1.5 cm long.

Very steep slopes, rocky hillsides in deciduous or open mixed forests in light, well-drained soil. Alabama, Georgia, South Carolina. April, May.

21. *Rhododendron roseum* (Loisel.) Rehder *in* Wilson & Rehder. A monograph of Azalea. p. 138. 1921.
   Azalea rosea Loiseleur-Deslongchamps *in* Duhamel, Traité Arb. Arbust. Ed. 2., v. 224, t. 64. 1812.
   Azalea canescens Pursh. Fl. Am. Sept. 1:152. 1814. (in part)
   Azalea nudiflora ɛɛ *rosea* Sweet. Hort. Brit. p. 265. 1826. (*nom. nud.*).
   Azalea nudiflora Darlington. Fl. Cestrica p. 26. 826.
   Rhododendron nudiflorum ɛɛ *roseum Sweet.*
   Hort. Brit. Ed. 2 p. 344. 1830.
   Rhododendron nudiflorum (Darlington) Darlington. Fl. Cestrica Ed. 2 p 262. 1837. (not Torrey)
   Rhododendron canescens Porter. Bull. Torr. Bot. Club XVI:220. 1889. (not Sweet)
   Azalea prinophylla Small. N. Am. Fl. 29(1):42. 1914.
   Rhododendron prinophyllum (Small) Millais. Rhododendrons. p. 229. 1917.
Election Pink. Early Azalea. Mountain Azalea. Roseshell Azalea.

Deciduous, upright shrubs 1-3 (-5) m tall with irregularly whorled branches, stoloniferous. Twigs gray-brown to light brown, finely pubescent, sparingly strigose, sometimes stipitate-glandular. Buds gray, pubescent, with generally ovate, obtuse, mucronulate, ciliolate scales 1 cm long. Leaves elliptic, obovate, obovate-oblong, acute or short-acuminate, cuneate at base, 3-7 cm long, 1-3 cm broad, ciliate, usually eglandular but sometimes stipitate-glandular, sparingly pubescent above, densely gray-villous beneath; midribs pubescent above, sparingly strigillose, sometimes stipitate-glandular beneath. Petioles soft-pubescent, sparingly strigose, 2-5 mm long. Flowers expanding with leaves, in clusters of 5-9, bright pink to magenta, rarely white, without blotch, with clove-pink fragrance. Pedicels finely villous, glandular-setose, 0.5-1.5 cm long. Calyx lobes semi-orbicular to ovate, unequal, finely pubescent, glandular-ciliate, scarcely exceeding 1 mm long. Corolla funnelform with oblique limb; tube cylindric, gradually dilated toward apex, with thin villous tomentum interspersed with numerous gland-tipped trichomes of unequal length, 1.5-2 cm long; lobes as long as or slightly shorter than tube, ovate, abruptly pointed. Stamens 5, slightly over twice tube length; filaments yellow-brown, pubescent below middle; anthers ochraceous, to 2 mm long. Style purple above, sparingly or densely pubescent below, exceeding stamens, 4-5 cm long. Capsules oblong, narrowed toward apex, sparingly puberulous, setosely glandular, 1.5-2 cm long.

Moist or dry woods or stream banks in Appalachian and Ozark Mountains. Southwestern New Hampshire, central Vermont, southwestern Quebec through New York, western and central Massachusetts, northwestern Connecticut, northern Rhode Island, Pennsylvania, northern New Jersey to eastern Ohio, southwestern Virginia; also western Tennessee, west central Arkansas, south and southeast Missouri, eastern Oklahoma. May, June.

22. *Rhododendron canescens* (Michx.) Sweet. Hort. Brit. Ed. 2 p. 343. 1830.
    Azalea lutea L. Sp. Pl. 1:150. 1753. (in part)
    Azalea nudiflora L. Sp. Pl. Ed. 2. 1:214. 1762 (in part)
    Azalea nudiflora ε *bicolor* Aiton. Hort. Kew. 1:203. 1789.
    Azalea canescens Michx. Fl. Bor.-Am. I:150. 1803.
    Azalea bicolor Pursh. Fl. Am. Sept. 1:153. 1814.
    Rhododendron bicolor Sweet. Hort. Brit. Ed. 2. p. 344. 1830.
    Rhododendron nudiflorum (L.) Chapman. Fl. S. U. S. p. 265. 1865. (not Torrey)
    Azalea nudiflora var. *canescens* Rehder *in* Bailey, Cycl. Am. Hort. I:12. 1900. (in part)
Wild Azalea. Piedmont Azalea. Florida Azalea. Wild Honeysuckle. Hoary Azalea.

Deciduous shrubs to 4 or 5 m tall with irregularly whorled upright branches, stoloniferous. Twigs yellow-brown, finely pubescent, sparingly strigose. Buds densely gray-pubescent, with broadly ovate, acuminu-late scales. Leaves oblong-ovate to oblanceolate or oblong, rarely elliptic or obovate, acute, rarely obtuse, mucronulate, cuneate at base, 4-9 cm long, setosely ciliate; above, sparingly pubescent or glabrescent with finely villous midrib; below, densely pubescent or gray-tomentose with densely pubescent, sparingly strigose midribs. Petioles finely pubescent, sparingly strigose, 2-7 mm long. Flowers expanding before or with leaves in 6-15-flowered clusters, pink with tube usually deeper pink than the lobes which may be almost white, slightly fragrant. Pedicels villous-pubescent, hirsute, sometimes stipitate-glandular, 0.5-1 cm long. Calyx lobes unequal, semi-orbicular to ovate, scarcely exceeding 1 mm, ciliate or glandular-ciliate. Corolla funnelform, to 4 cm dia; tube cylindric, abruptly dilated at apex, 1.5-2.5 cm long, sometimes nearly twice as long as lobes, densely and finely villous, stipitate-glandular; lobes ovate, acute or obtuse, 1.2-1.5 cm long, no yellow to orange blotch. Stamens 5, much exserted, nearly 3 times the tube length, with pink filaments pubescent below the middle, ochraceous anthers 1.5-2 mm long. Style pink, finely villous toward base, 4-6 cm long, as long or longer than stamens. Capsules cylindric-oblong, narrowed upward, slender, pubescent, sparingly setose, 1.5-2 cm long.

Moist sandy soil, often along streams. Southern Atlantic and Gulf Coastal Plain from Virginia to Florida and west to Oklahoma, southeastern Texas; Piedmont of Virginia, North Carolina, Georgia, Tennessee, Mississippi Embayment. April, May, sometimes as early as January.

23. *Rhododendron oblongifolium* (Small) Millais. Rhododendrons. p. 219. 1917.
    Azalea oblongifolia Small. Fl. S.E. U.S. p. 883, 1336. 1903.
Texas Azalea.

Deciduous shrub 2 m tall or less, with irregularly whorled branches, sometimes stoloniferous. Twigs with short, sparse villous pubescence, sparingly strigose, sometimes nearly glabrous, orange-brown. Buds with ovate, acuminulate or obtuse, gray-pubescent scales. Leaves obovate, elliptic-obovate, oblong-oblanceolate, rarely oblong, 4-10 cm long, 1.5-4 cm broad, acute, mucronulate, cuneate, ciliate; dull green, glabrous, sometimes strigillose, minutely pubescent above, light green, rarely glaucescent, more or less pubescent or nearly glabrous beneath; midribs villous above, pilose and strigillose beneath. Petioles finely pubescent, 2-3 mm long. Flowers expanding after the leaves in 7-12-flowered clusters, white, no blotch, fragrant (lemon oil scent). Pedicels sparingly villous, glandular-hirsute, 5-7 mm long. Calyx lobes unequal, ovate, oblong, lanceolate, obtuse to acute, 1-3 mm long, long ciliate, sparingly villous. Corolla funnelform; tube cylindric, 2.5-3 cm long, abruptly dilated at apex, thinly villous, sparingly glandular-hirsute; lobes oblong-ovate, acute, 1.5-2 cm long; stipitate-glandular along middle. Stamens 5, twice as long as tube, slightly exceeding lobes; filaments white, villous below middle; anthers ochraceous, 2.5-3 mm long. Style exceeding

stamens, 5-6 cm long, finely pubescent at lower third or sometimes glabrous, white. Capsules oblong, ovoid-oblong, or narrow-oblong, finely villous, stipitate-glandular, 1-2 cm long.

Sandy soils along high stream banks, open woods, occasionally in sandy, freshwater bogs, on slopes with exposed rocks. Arkansas, Louisiana, Oklahoma, Texas. Late April, May.

24. *Rhododendron viscosum* (L.) Torrey. Fl. U.S. p. 424. 1824.

  Azalea visocosa Linnaeus. Sp. Pl. 1:151. 1753.

  Azalea viscosa palustris Marshall. Arbust. Amer. p. 16. 1785.

  Rhododendron venustrum Salisbury. Prodr. p. 287. 1796. (in part)

  Azalea nitida Lindley. Bot. Reg. V, t. 435. 1819. (not Pursh)

  Anthodendron viscosum (L.) Reichenbach *in* Moessler, Handb. Gewächsk. Ed. 2, 1:309. 1827.

Swamp Honeysuckle. Swamp Azalea.

Deciduous shrubs to 3 or nearly 5 m tall, sometimes low, with irregularly whorled branches, stoloniferous. Twigs yellow-brown or gray-brown, hirsute or strigose. Bud glabrous, sometimes pubescent, usually brown with 8-12 broadly ovate scales rounded at apex and usually mucronate, ciliolate; basal scales sometimes long-pointed. Leaves ovate, elliptic-obovate or oblong-lanceolate, acute or rounded, mucronulate, cuneate, 2-6 cm long, 0.5-2 cm broad, ciliate, glabrous; midrib slightly villous above, more or less strigose beneath. Petioles strigillose, 1-3 mm long. Flowers appearing after the leaves, white, rarely pink, no blotch, in clusters of 4-9, fragrant. Pedicels minutely pubescent, stipitate-glandular, 0.5-1 (-1.5) cm long. Calyx lobes semi-orbicular to ovate, setosely glandular-ciliate, about 1 mm long. Corolla funnelform, 1-5 cm dia; tube cylindric, somewhat dilated near the apex, finely villous, stipitate-glandular, about 1.5 cm long. Stamens 5, exserted, somewhat longer than lobes; filaments villous on lower two-thirds, white, 4-5.5 cm long; anthers yellow, 1-2 mm long. Style finely pubescent below middle, white, sometimes purple toward stigma, 4-6 cm long, exceeding stamens. Capsules oblong-ovoid, finely pubescent, glandular-setose, sometimes setose and eglandular, 1-2 cm long.

Common in swamps of Coastal Plain to higher mountains. Maine to Florida; west to Ohio, mountains of Pennsylvania to North Carolina, Tennessee; Mississippi, Arkansas, Louisiana, southeast Texas. April to June.

25. *Rhododendron serrulatum* (Small) Millais. Rhododendrons. p. 241. 1917.

  Azalea viscosa Hooker. Comp. Bot. Mag. 1:100. 1835. (Not Linnaeus)

  Rhododendron viscosum Chapman. Fl. S. U.S. p. 265. 1865. (not Torrey)

  Azalea serrulata Small. Fl. S.E.U.S. p. 883. 1903.

  Rhododendron viscosum var. *serrulatum* (Small)

Ahles. Jour. Elisha Mitchell Sci. Soc. 80:173. 1964.

Hammocksweet Azalea.

Deciduous tall shrubs or small trees to 7 m tall with irregularly whorled branches and radiating white rhizomatoid root systems. Twigs bright red-brown, copiously strigose, finely villous. Buds glabrous or sometimes gray-pubescent with 15-20 ovate, mucronate or mucronate-aristate scales usually light yellow-brown with a sharply marked dark brown band along the white-ciliolate margin. Leaves elliptic, obovate or obovate-oblong, rarely oblanceolate, 4-8 cm long, 1.5-3.8 cm broad, acute, rarely obtuse, mucronulate, cuneate at base, serrulate-ciliate margins, glabrous above and beneath, midribs sparingly short-villous above and strigose beneath. Petioles strigose, 1-4 mm long. Flowers expanding after the leaves and after winter buds are partially formed, white, in clusters of 6-10, no blotch, very fragrant clove-pink scent. Pedicels minutely pubescent, stipitate-glandular, 1-2 cm long. Calyx lobes semi-orbicular to ovate, long glandular-ciliate, to 1 mm long. Corolla funnelform, 2-3 cm dia; tube cylindric, slender, 2.5-3.5 cm long, 2 mm wide, slightly dilated at apex, copiously stipitate-glandular, sparingly villous; lobes ovate, lanceolate, acuminate, 1-1.5 cm long. Stamens 5, exserted about 1½ times tube length; filaments yellow, lower two-thirds villous; anthers ochraceous, oblong, 2-2.5 mm long. Style considerably exceeding stamens, slightly short-pubescent near base or glabrous, purple above, 4.5-6 cm long. Capsules ovoid-oblong, minutely villous, densely glandular-setose, 1-1.5 cm long.

Wet woods, Coastal Plain of Virginia, North and South Carolina, Georgia, Florida westward to Louisiana. June to early August.

26. *Rhododendron arborescens* (Pursh) Torr. Fl. U.S. p. 425. 1824.

  Azalea arborescens Pursh. Fl. Am. Sept. p. 152. 1814.

  Azalea verticillata Carr. Cat. Trees & Shrubs Bartram's Bot. Gard. p. 11. 1814.

  Azalea arborea Bartram ex Pursh. Fl. Am. Sept. p. 152. 1814. (as synonym)

  Azalea fragrans Rafinesque. Ann. Nat. p. 12. 1820. (not Adams)

Smooth Azalea. Sweet Azalea.

Deciduous tall shrubs or small trees to 6 m tall, not observed to be stoloniferous. Twigs yellow to light gray-brown, glabrous. Buds glabrous; scales light brown, ovate, ciliate, with rounded base, mucronulate apex. Leaves oblanceolate, bright green, ciliate, glabrous except for midribs, sparingly short-villous above and sparingly strigose beneath. Petioles glabrous, 3-8 mm long. Flowers expanding after leaves have unfolded, white to pink, no blotch on lobes, in clusters of 3-8, very fragrant. Pedicels red stipitate-glandular, 0.5 cm long. Calyx lobes ovate to linear-oblong, glandular-ciliate, 3-6 mm long. Corolla funnelform, 3-4.5 cm dia; tube 2-3 cm long, sparingly red stipitate-glandular,

slightly dilated at apex; lobes ovate-oblong, acuminate, 1.5-2 cm long. Stamens 5, exserted, about twice as long as tube; filaments purple above, pubescent below the middle; anthers 2-3 mm long, ochraceous. Style as long or longer than stamens, purple above, glabrous. Capsules oblong-ovoid, 0.5-2 cm long, densely glandular-hispid.

Banks of mountain streams, rarely on the borders of swamps. Appalachian Mountains, Pennsylvania to Georgia, Kentucky, Alabama. Late June, early July.

27. *Rhododendron prunifolium* (Small) Millais. Rhododendrons. p. 230. 1917.
   Azalea prunifolia Small. Fl. S.E.U.S., Ed. 2 p. 1356. 1913.

Plumleaf Azalea.

Deciduous shrubs to small trees over 5 m tall with irregularly whorled branches, often stoloniferous. Twigs glabrous, dark purple-red. Buds glabrous, orange to red brown, with broadly ovate, rounded, mucronulate, sometimes nearly aristate, ciliolate scales 1-1.25 cm long. Leaves elliptic, sometimes obovate to oblong, acute or short acuminate, mucronulate, cuneate, 3-10 (-13.5) cm long, 1.5-4 cm broad, ciliate, glabrous above, very sparingly strigillose beneath, midribs slightly villous above and sparingly strigose beneath. Petioles glabrous or rarely sparingly strigose, 3-6 mm long. Flowers opening after leaves have expanded, in 4-5-flowered clusters, crimson, no blotch on lobes, not fragrant. Pedicels hirsute, 5-7 mm long. Calyx lobes semi-orbicular to ovate, glabrous, longciliate, 1-1.5 mm long. Corolla funnelform; tube gradually widened above middle, 2-2.5 cm long, glabrous, sparingly hirsute or sparingly stipitate-glandular; lobes broadly ovate, abruptly acuminulate, 1.5 cm long, 1-1.5 cm broad, more or less finely villous, sometimes slightly glandular-pilose. Stamens 5, much exserted, nearly 3 times tube length, 5-6.5 cm long; filaments yellow, villous on and below the middle; anthers ochraceous to yellow, 2-3 mm long. Style to 8 cm long, much exceeding stamens, glabrous, purple above, Capsules ovoid-oblong, strigose, finely puberulous, 2 cm long.

Shady ravines on stream banks. Southwestern Georgia, eastern Alabama. June-September.

Putative Hybrids and Species Transferred to Other Genera

Rhododendron fastigifolium (Lemmon) Hume. Azaleas, Kinds and Culture, p. 28. 1948.
   Azalea fastigifolia Lemmon. Bartonia 19:15. 1938.
Rhododendron furbishii (Lemmon & McKay) Hume. Azaleas, Kinds and Culture, p. 28. 1948.
   Azalea furbishii Lemmon & McKay. Bartonia 21:5-6. 1940.

These two taxa are putative hybrids described from areas known to have hybrid swarms of *Rhododendron.* Leach (1959) reported that in the crosses he made with *R. bakeri* and *R. arborescens* in an effort to duplicate "*R. furbishii*", resulting hybrids were almost identical with those described by Lemmon. He also found that plants grown from seeds resulting from self-pollination of wild "*R. furbishii*", proved to be a segregating population with characteristics of *R. Bakeri* and *R. arborescens*. A similar situation obtains for *R. fastigifolium,* although the crosses have not been reported. Lee (1965) says "Material described under *fastigifolium,* with smaller red flowers and orange-yellow blotch, probably falls within the *speciosum-canescens* complex. Of the thirteen plants of *fastigifolium* originally discovered and transplanted, only a few are apparently still in cultivation." These taxa should be regarded as hybrids with the names *R.* × *furbishii* and *R.* × *fastigifolium.*

Rhodothamnus leachianus (Henderson) Copeland. Amer. Midl. Nat. 30:565. 1943.
   Rhododendron leachianum Henderson. Rhodora 33:205. 1931.
   Kalmiopsis leachiana (Henderson) Rehder. Jour. Arnold Arb. 13:31-32. 1932.

Rehder considered this taxon to have enough characters different from *Rhododendron* that he placed it in a new genus, *Kalmiopsis.* However, Copeland found that *Kalmiopsis* was sufficiently like *Rhodothamnus* that it should no longer be maintained as a separate genus. Therefore, he merged it with *Rhodothamnus,* which has nomenclatural priority.

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NOTES

VIRGINIA
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Guliday, John E. 1971. Pleistocene History of the Appalachian Mammal Fauna. *In* Distributional History of the Southern Appalachians, Part III. Vertebrates (Perry C. Holt, ed.), pp. 223-262. VPI & SU, Blacksburg, Va.

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Virginia Academy of Science
Fifty-Ninth Annual Meeting, Old Dominion University
May 12-15, 1981

The Awards Committee

Upon recommendation by the Awards Committee and by election by Council, four people have been designated as Fellows in the Virginia Academy of Science because of their contribution to science in one or more of the following ways: (a) outstanding scientific research, (b) inspirational teaching of science, (c) significant leadership in the Academy.

Let me pause at this point and remind everybody that at least three nominations or endorsements for each 1982 Fellow candidate must be submitted in writing to the Awards Committee or the Executive Secretary before June 1 of this year.

The vita of each person being named a Fellow this year shows extensive scientific achievements, but I shall cite only a few.

The first person has been an outstanding high school teacher for many years in Wise and Tazewell Counties and the city of Williamsburg. He has served as Science Supervisor in Old Norfolk County, City of Portsmouth and City of Fredericksburg, as Assistant Superintendent of Fredericksburg City Schools and as a consultant to the U.S. State Department in Germany.

A native of Southwest Virginia, he holds the B.A. degree from Emory and Henry College and the M.S. degree from George Peabody College. He either has done graduate work or has teaching experience at eight different universities. He has written five books for high school science students and is the author of numerous science articles and pamphlets in the field of education, marine biology and folklore.

He is the recipient of the Distinguished Science Award from Emory and Henry College and from the Virginia Junior Academy of Science. Last, but not least in any sense, he was the first Director of the Virginia Junior Academy of Science.

For these achievements and contributions, the Virginia Academy of Science names as a Fellow of the Academy, Mr. **Hubert J. Davis.**

The second person chosen to be a Fellow is truly a man of distinction and a loyal supporter of the Academy for many years. He is a renowned physicist and university educator, earning both the B.A. and Ph.D. degrees at the University of Virginia. As a student at the University, he was elected to Phi Beta Kappa, Omicron Delta Kappa and the University's own leadership society, the Raven Society.

After 25 years as a teacher and administrator at the University of Virginia, he was named the fifth president of the University in 1974. He was awarded the

Thomas Jefferson Award in 1966, perhaps the most coveted award bestowed of the University. With all the demands and responsibilities of a university president, he still finds time for the Academy, the latest as a panelist on the Negus symposium at last year's Annual Meeting. He also was a co-recipient of the J. Shelton Horsley Research Award in 1953.

In recognition of his scientific contributions, his educational leadership in the state of Virginia and his loyal support of the Virginia Academy of Science, the Academy hereby names as a Fellow, Dr. **Frank L. Hereford, Jr.**

The third person elected as a Fellow is a botanist by training. After earning the B.S. degree at Stetson University, he began his career teaching biology and natural science in the public schools in Florida and Maryland. For the past 17 years he has been with the U.S. National Arboretum in Washington, D.C. as a herbarium curator. He is a leading authority on trees and wildflowers having traveled and written extensively in his field. He is often called on by the Shenandoah National Park and local institutions to counsel and instruct in many botanical activities.

Perhaps is greatest recognition has come from the role he played in the research and rediscovery of *Betula uber* in Southwest Virginia, an unusual birch tree thought to be extinct. For this, he was named a co-recipient of the J. Shelton Horsley Research Award in 1976. He has also chaired the Flora Committee and served on the Academy Council.

For these scientific achievements and Academy support, the Academy hereby names as a Fellow, Mr. **Peter M. Mazzeo.**

The fourth person being named a Fellow in the Academy earned the B.S. degree from Lynchburg College and the Ph.D. degree from the University of Virginia. He joined the University of Richmond faculty in 1952 and has served very effectively as chairman of its Department of Biology since 1965.

Perhaps his greatest recognition has been his contribution to and leadership role in the Academy, always in a rather quiet but effective manner. He has served on the Academy Council for many years as a representative of the Biology section, as chairman of the Membership Committee and currently, very ably, as Secretary of the Academy.

For this true dedication to the Academy and his academic science leadership role, the Academy names as a Fellow, Dr. **Warrick R. West.**

Three people have had conferred upon them Honorary Life Memberships in the Virginia Academy

of Science in recognition of their long and distinguished service to science. The first person is a graduate of William and Mary where he was elected to Pi Kappa Alpha, Alpha Kappa Psi and Phi Kappa Phi. He enjoyed a long and illustrious career with the American Tobacco Company wherein he progressed from Chemist, to Division Head, to Assistant Director of Research, to Assistant to Vice President for Research and Development, and finally to Director of Technical Information and Coordinator of Community Relations.

He served as Business Manager of the Virginia Journal of Science from 1967 to 1970, and has been a sustaining member of the Academy for many years. He is also a Fellow in the Academy and a recipient of the Virginia Junior Academy of Science Distinguished Service Award.

Perhaps you know him best as our Executive Secretary-Treasurer for the past ten years. In this capacity he has earned the undying gratitude of all of us in his efficient administration of the business of the Academy. It is only fitting that we show our appreciation for this dedicated service by naming as an Honorary Life Member of the Virginia Academy of Science, Mr. **Blanton M. Bruner.**

The second person holds three degrees from the University of Florida, the B.S., M.S. and Ph.D. in Biology. He served on the Biology faculty of both Florida and the University of Virginia, and at the latter, served as Director of the Mountain Lake Biological Station for six years. For the past 19 years he has been Head Curator and Senior Zoologist of the Smithsonian Institution's Department of Invertebrate Zoology at Washington, D.C. He is a member of some fifteen professional and honorary societies, serving as president of the American Microscopical Society and of the Association of Southeastern Biologists.

His scientific foreign travel has been very extensive, and he is the author of some 150 scientific articles and books.

His Virginia Academy of Science involvement is also quite envious. As an Academy Member since 1946, including sustaining membership the past 10 years, he served as Technical Editor and Editor of the Virginia Journal of Science for 7 years, as a member of Council for 14 years and as President in 1961-62. He is a Fellow in the Academy, and is a recipient of both the J. Shelton Horsley Research Award and the Ivey F. Lewis Distinguished Service Award.

For this long and distinguished service to science and the Academy, an Honorary Life Membership in the Academy is hereby bestowed on Dr. **Horton H. Hobbs, Jr.**

The third Honorary Life Member recipient is also a scientist of equal distinction. He received the B.A. degree from Bridgewater College, and the M.S. and Ph.D. degrees from the University of Virginia. His professional experience as a horticulturist—genetics as a discipline—included the staffs of Bridgewater College, Harvard University, Texas A&M University, University of Virginia, Virginia Tech and Wake Forest University where he retired last year as Professor Emeritus.

He has held, or is holding memberships in over twenty scientific societies and organizations, he has traveled abroad to many countries on scientific missions and he has over 100 technical articles to his credit. He is listed in 17 types of Who's Who.

His Virginia Academy of Science involvement and achievements includes membership for the past 52 years, member of many committees, a Fellow, a recipient of both the J. Shelton Horsley Research Award, and the Ivey F. Lewis Distinguished Service Award and President of the Academy in 1955.

It is a privilege to name as an Honorary Life Member of the Acadmey, Dr. **Walter S. Flory, Jr.**

Ivey F. Lewis Distinguished Service Award

The Ivey F. Lewis Distinguished Service Award is the highest honor the Academy can bestow. It is presented periodically for significant contributions toward the activities of the Virginia Academy of Science. For only the second time in the 25-year history of this award the recipient for 1981 is a company rather than an individual. The 1981 recipient of the Ivey F. Lewis Distinguished Service Award is Philip Morris, and Company.

Aside from being a business member of the Academy for many years, the most significant support has been to the Junior Academy program. The support, primarily, has been in the form of annual grants over the past 20 years for student paper awards and Philip Morris personnel attending the Annual Meeting to present the awards. At present the grant is $2200 plus sponsoring a new VJAS fund-raising brochure whereby Philip Morris will provide the services of its art development and print 3,000 copies of the 8-page brochure.

Several of the Philip Morris personnel should be cited for the administration of the grants and for attending the annual Junior Academy meetings to make the student awards. They are Dr. Helmut R. Wakeham, Director of Research and a 1980 VAS Fellow recipient; Dr. Robert B. Seligman, Vice President of the Division of Research and Development; Mr. Robert W. Norris, Manager of Corporate Relations; Mr. Ralph E. Antell, Manager of Administrative Services; and Mr. Bernie J. Kosakowski, Manager of Administrative Services, succeeding Mr. Antell.

The Virginia Academy of Science bestows the 1981 Distinguished Service Award upon **Philip Morris, Inc.**

E. L. Wiseman, Chairman

Constitution and Bylaws Committee

Proposed Bylaw changes must be distributed to the membership or published in the *Virginia Journal of Science* at least 30 days prior to action by Council. Adoption requires an affirmative vote of a majority of the *total* membership of Council.

Council approved the following at the May 14 meeting of the 1980-81 Council;

Amend; Article I, Types of Membership and Dues, Section 2, Paragraphs 1 thru 4 to read as follows;
  (1) Regular members shall pay annual dues *fifteen dollars ($15.00).*
  (2) Student members shall pay annual dues *of five dollars ($5.00).*
  (3) Contributing members shall be members who elect to pay annual dues of *twenty dollars ($20.00).*
  (4) Sustaining members shall be individuals and institutions who elect to pay annual dues of *thirty dollars ($30.00)* or more.

To be effective for fiscal year beginning January 1, 1982 and thereafter until changed.

J. W. Midyette, Jr., Chairman

Finance and Endowment Committee

a) From the report presented here, prepared by the committee and submitted to Council in Nov. 1980 by A. W. Burke, a trend of dwindling reserves in the General Fund is apparent. At least two steps have been taken, or proposed to reverse this trend are now in effect:
  1. Reduced outlay for support of Va. Journal of Science, following guidelines established by Council in 1980.
  2. Increased dues structure, with the resulting increased income to be earmarked to restore the General Fund.

b) Membership statistics for 1980 show little change over the past three years. This seems a fertile area for growth.

K. P. Bovard, Chairman

Flora Committee

The Flora Committee met on May 14, 1981 at Old Dominion University. Taxonomic work on various plant groups was discussed. A paper on Phrymaceae and Plantaginaceae has been published and one on *Rhododendron* is in press. Work on the milkweeds (Asclepiadaceae) and *Sisyrinchium* is in progress. Study of certain members of the Heath Family (Ericaceae) is to be initiated.

Funds for publication of the brochure on careers and avocations in botany are slowly accumulating and amount to 29% of the $650 needed.

The priority listing of threatened and/or endangered plants has not yet been compiled. Persons performing for the Nature Conservancy are working on such a listing or may have already compiled it. The status of this listing is to be discussed at the next Flora Committee meeting.

Peter Mazzeo reported that only about half of the original number of trees of *Betula uber* are extant in the type location.

The project of compiling a bibliography of Virginia's floristically related literature was discussed. The opportunity to revive this project is presented to the new chairman of The Flora Committee.

Representation of The Flora Committee and The Botany Section at the fall Science Teacher's Conference was discussed. If it is held in Roanoke, Dr. Martha K. Roane will represent the botanists. Contact with Mr. Exline regarding the conference will be made by the new chairman of The Flora Committee.

Jeffersonia, the botanists' newsletter, is financially stable. Volume 12(1) has been issued. Martha Roane will continue editing it through the completion of Volume 12.

The committee designated $100 for work on the Santalaceae and Orobanchaceae by Lytton Musselman and $150 for work on threatened and/or endangered plants by Donna Ware. There was a discussion of the purpose of the research funds. The consensus was that these funds are to be used only for floristic research.

The possibility that the fall meeting of The Flora Committee be held in 2 sections, an eastern and a western, was discussed. Also the possibility of field trips was brought up. Resolution of these suggestions is turned over to the new chairman of The Flora Committee.

Martha K. Roane, Chairman

Membership Committee

The Membership Committee performed its tasks in much the same way as has been done over the past few years. However, it is not very gratifying to report that membership dropped to 1,494 as of 1/1/81 from 1,530 in 1/1/80. Sixty-seven new members have been added in the first four months of 1981.

Letters were sent to 276 people whose names appeared in VAS Virginia Scientist Program who were not members of the Academy. They were asked to join the VAS and enjoy the benefits of being a supporting member of the Academy.

Letters and brochures were sent to eighteen laboratories and consulting firms in the Washington, D.C. area asking them to participate in the Virginia Academy of Science.

Dr. Peter Trower of the Physics Section sent numerous brochures and invitations to prospective members. Perhaps we can determine the results of this mailing after this annual meeting.

Michael L. Bass, Ph.D., Chairman

Summary of Receipts and Disbursements — 1978-81

| | Actual | | Budget | | Budget |
	1978	1979	1980		1981
Receipts					
Dues	$16,950	$18,200	$18,100		$18,400
Gifts (esp. VJAS)	5,417	5,327	7,200		5,000
Annual Meeting	9,164	6,666	6,900		6,400
Va. Journal of Sci.	4,014	2,855	1,650		4,020
Interest	1,802	2,676	1,800		1,500
Income/Trust	2,200	2,200	3,300		4,000
Other	674	417	---		---
Total:	$40,221	$38,341	$38,355		$39,320
				Disbursements[a] to 1981 Oct. 31	
Disbursements					
Salaries & Benefits	3,105	3,385	3,850	2,979	3,900
General Expenses	3,372	3,593	3,020	3,268	3,900
Meeting Expenses	3,156	3,515	3,200	2,333	3,300
VJAS	10,802	9,524	11,535	7,797	10,000[b]
Va. J. Sci.	18,088	21,774	11,650	14,871	14,020[c]
Research & Horsley	2,429	2,600	3,350	3,143	3,800
Vist. Sci. Prog.		1,428	750	719	800
Flora Comm.	(300)	300	300	300	300
Contingency Fund		316	400	270	400
NEWSLETTER[d]	---	---	---		400
AAAS Rep./travel		304	300	453	400
	962				
Total:	$41,914	$46,739	$38,355	$36,133	$41,220
Operating Deficit	1,693	8,398	---		1,900
General Fund	42,749	34,774		Est. 30,000	Est. 28,000

[a]**Notes to Financial Data:** Actual disbursements to 1980 October 31 are itemized for reference use only. Anticipated and/or possible significant "year end" expenditures include: Journal +2,500; VJAS +2,500 — travel and printing; Salary and General +1,250, or **Estimated** $7,250 to Dec. 31. **This will project a deficit for 1980** of about $5,000 (36G + 7G – 38G)

This will project a further erosion of the General Fund to $30,000.

[b]The proposed budget figure includes the $5,000 direct subsidy, as requested by the VJAS Committee, and a VAS guarantee of $5,000 direct subsidy, as requested by the VJAS Committee, and a VAS guarantee of $5,000 for anticipated and reasonably expected gifts "earmarked" for VJAS activities (e.g. Philip Morris = 2,100, ATC = 400, & other reasonable = 2,500). Any funds/gifts raised by the VJAS, **over and above these guaranteed amounts,** would accrue exclusively to benefit to VJAS.

[c]The proposed budget figure includes the "ceiling" placed by 1980 council of $10,000 **plus** the estimated revenues of $4,020 by the Journal.
[d]New item; NEWSLETTER.

Virginia Academy of Science
MEMBERSHIP STATISTICS, 1978-80

	1978	1979	1980
Membership Begin. Year	1,360	1,466	1,530
Add	224	240	141
Resign & Died	−26	−49	−55
Dropped—Non Pay.	−92	−127	−122
End of Year	1,466	1,530	1,494
Regular	1,165	1,197	1,165
Contributing	100	100	95
Sustaining	53	57	58
Student	113	139	138
Life	16	20	19
Business	19	17	19

Research Committee

R. C. Bates assumed the Chairmanship of the Research Committee on January 1, 1981. Since January 1st, 6 proposals have been received and reviewed. Four research grants were awarded for a total of $1,381. One proposal was returned for a budget revision and one proposal was not funded.

Six research papers were submitted in competition for the 1981 J. Shelton Horsley Award. The papers were again kindly reviewed by the Sigma Xi Chapter of West Virginia University. The author of this paper will receive a check for $500 and a certificate.

The review process for research proposals is presently undergoing modification and revision. It is anticipated in the face of an increasing number of proposals that we will not be able to fund (with our limited funds) all worthy requests in the future. Therefore, the committee is considering establishing two deadlines (April 15th and October 15th each year) for receiving applications for research funds. This would allow us to select the most outstanding projects for funding.

Preparations are being made for advertisement and distribution of funds, when they become available, from the Horsley Cancer Research Fund. Dr. Banks is involved in developing guidelines for this new activity of the Research Committee.

Members of VAS, who seek financial support of their research in the form of small grants (viz., less than $500), should contact R. C. Bates for application forms and further information at the Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061; Phone: 703-961-5702.

Robert C. Bates, Chairman

Science Advisory Committee

I am happy to report to the Academy that after five years of persistent effort on the part of the Committee to Plan a Science Advisory System we have had a very encouraging response in the form of a policy statement from Governor John N. Dalton. On May 27, 1980, pursuant to the report on the "State Science, Engineering and Technology Capacity in State Government" December 1978, Governor Dalton issued the following policy memorandum.

"It shall be the policy of the Commonwealth to apply as effectively as possible, scientific and technological information and expertise to the analysis of policy options and the resolution of major state problems.

Virginia is fortunate in having scientific and engineering expertise upon which to call. State agencies are presently utilizing many of these resources, but more effective and greater use of them is encouraged. Closer coordination between the State and its scientific community is necessary. To this end, the Governor's Science and Technology Advisor and Science and Technology Advisory Committee shall be continued to improve communications between State agencies and the State's scientific community.

A continuing role within State government, however, is also necessary. The Department of Planning and Budget shall serve as the agency responsible for overseeing the implementation of this policy and for supporting the activities of the Governor's Science and Technology Advisor and the Science and Technology Advisory Committee. All agencies in the executive branch shall work with the Department in carrying out this responsibility.

In general, the Department shall develop and implement procedures for assuring more effective use of science and technology information within State government. More specifically, the Department shall:

- Advise the Secretaries and State agencies on the scientific and technological content of major issues.
- Maintain liaison and knowledge of scientific expertise within State agencies, the academies and private sectors, as well as with major federal research laboratories and agencies.
- Identify resources to aid in conducting professional policy analyses of issues with scientific and technological content and assist State personnel in utilizing such resources.
- Review policy analyses and legislative proposals for the scientific and technological content.
- Build upon the previously compiled resource inventory to identify resources for use by Agency and Secretarial personnel.

The Department shall also be responsible for re-evaluating, on a continuing basis, the effectiveness of the State's efforts to improve the utilization of scientific and technological information in its decision-making process. This evaluation should not only focus on the use of such information, but also focus on the means by which the State mobilizes the resources available to meet the objectives outlined in this memorandum."

The efforts of the Science Advisory Committee have been devoted to expanding the inventory of resource personnel in cooperation with the Department of Planning and Budget. Approximately 550 scientists and engineers have volunteered their services and the file is currently being cross-referenced and developed in a format which can be circulated to all state agencies.

The Chairman of the Science Advisory Committee, in response to an invitation from the Association of State Academies of Science, participated in a symposium entitled "Promoting Science at the Grass Roots Level—The Local Academy, A Successful State Government Liaison Program" at the AAAS meeting in Toronto, Canada, January 5, 1981. The progress report on the activities of the Virginia Academy received a very good response from participants.

Ertle Thompson, Chairman

Virginia Junior Academy of Science

The 1981 meeting had 54 clubs to register which includes 453 students, sponsors and teachers. From a total of 374 papers 203 were selected to be read. Very few failed to show. The VJAS committee performed their duties well so activities were successfully completed. The speaker, Dr. S. N. Postlethwait, Purdue University, was well received. His talk on "The Wonderful World of Plants" was a multi-image presentation. The awards program was held on May 14. All regular and special awards were given. New officers were elected. Thanks to the support and effort of Dallas Cocke and Philip Morris, Inc., a brochure to be used in fund raising efforts has been prepared and printed. This tool will be of considerable value to use to help the VJAS become more self-supporting.

R. Dean Decker, Director, VJAS

Botany Section

In an invitational session on "Current Vegetational Ecology Research in Virginia Forests" organized by Frank P. Day, Jr. and Terry L. Sharik, a number of very fine papers were presented. Other papers presented ranged in topics from phytoplankton studies to the flora of Antarctica. The paper sessions were interesting and well attended.

In the business session, new officers were elected. Items of business discussed were participation in the Science Teachers' Conference in the fall, the progress of the brochure on careers and avocations in botany and the status of Jeffersonia. The councilor reported on items of interest from The Academy council meeting on May 14, 1981.

Martha K. Roane

Geology Section

The Geology Section of the VAS had 26 papers scheduled for the 1981 Annual Meeting, held at Old Dominion University. The number of papers necessitated holding the meetings on two days; the Friday morning session included a mini-symposium on Virginia Piedmont geology. There were several excellent papers given by students. The competition for the annual award for best student paper was a tie and the award was shared by Karen Bice of the College of William and Mary and Robert R. Seal, II of VPI & SU; both are undergraduates. An additional award, one for the best paper on economic geology by a student, will be given in 1982. We are looking forward to another round of fine papers and discussions at the 1982 session, which is to be held in Blacksburg.

S. O. Bird, Secretary, 1981

Editor's Report

Though the Virginia Journal of Science is now back on schedule and being printed at half of its previous costs, the Publications Committee and Council have directed that the Editor and Business Manager move to have the Journal printed by photoreproduction of camera-ready copy (as is done with the abstracts of the Proceedings Issue), eliminating the cost of most typesetting. While the Editor feels obligated to publish all already accepted papers by set type, he expects to move entirely to the revised format by the end of the 1982 volume.

Because the Editor will be without office space from June until October while peeling asbestos insulation is removed from the Biology building at William and Mary, the Proceedings Issue of the Journal may be delayed.

Abstracts of Papers
Aerospace Science Aeronautics and

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University

EFFECT OF BOUNDARY LAYER GROWTH ON THE THREE-DIMENSIONAL
STABILITY OF TRANSONIC AND SUPERSONIC FLOWS. N. M. El-Hady*
Dept. of Mech. Engg. & Mechanics, ODU, Norfolk, Va. 23508
    The method of multiple scales is used to describe a
formally correct method based on the nonparallel linear
stability theory, that examines the two- and three-dimen-
sional stability of compressible boundary-layer flows. The
method is applied to the supersonic flat plate boundary
layer at Mach number 4.5. The theoretical growth rates are
in good agreement with the experimental results of Kendall.
The method is also applied to the infinite-span swept wing
transonic boundary layer with suction to evaluate the effect
of the nonparallel flow on the development of crossflow
disturbances.
    The work was supported by the NASA Langley Research
Center, LFCAEO, Grant NSG1645.

GÖRTLER INSTABILITY IN COMPRESSIBLE BOUNDARY LAYER WITH
SUCTION OR COOLING. N. M. El-Hady*, A. K. Verma*. Dept.
of Mech. Engg. & Mechanics, ODU, Norfolk, Va. 23508
    The instability of the laminar compressible boundary
layer flow along a concave wall is investigated. A com-
pressible linear stability theory is presented for the
three-dimensional longitudinal type vortices in two-dimen-
sional boundary layers with suction or cooling along the
concave wall. The analysis includes the effect of the
boundary layer growth, that is, the velocity component nor-
mal to the curved wall, as well as the streamwise variation
of the meanflow quantities.
    Compressibility reduces the growth rates and amplitude
ratios of these vortices. This effect is evaluated for a
range of Mach numbers from 0 to 5. The effect of wall
cooling and suction of the boundary layer on the develop-
ment of these vortices is investigated at Mach number 3.
Cooling or suction seems to locally destabilize the boundary
layer in terms of the critical Görtler number; however, it
reduces the total streamwise growth of the vortices. An
evaluation is presented for the effectiveness of cooling or
suction in delaying transition caused by Gortler vortices.
    This work was supported by the NASA Langley Research
Center, LFCAEO, under Grant NSG 1645.

NITROGEN CONDENSATION-COMPARISON OF AIRFOIL EXPERIMENTS
WITH HOMOGENEOUS NUCLEATION THEORY. R.M. Hall, P. B.
Gooderum*, and E. H. Dotson*, NASA Langley Research Center,
Hampton, Va 23665

    Avoidance of condensation effects due to homogeneous
nucleation (self-nucleation) of the test gas has long been
a concern during the operation of most transonic and super-
sonic wind tunnels. Renewed interest in condensation has
resulted from the development of cryogenic, transonic wind
tunnels which use low temperature nitrogen gas as the test
medium. Until recent airfoil experiments in the Langley
0.3-m Transonic Cryogenic Tunnel, however, very little
data were available for comparisons between theory and
experiment in the pressure and temperature regions of
interest to cryogenic tunnels. The agreement between the
new data and theory will be discussed and conclusions made.

CONTROL OF LARGE SPACE STRUCTURES: A CHALLENGE OF THE
FUTURE. S. M. Joshi* Vigyan Research Associates, Inc.,
28 Research Drive, Hampton, VA 23666 (presently with Old
Dominion University Research Foundation, Norfolk, VA 23508.)
    A number of potentially important, new space initiatives
and missions require large space structures (LSS) with
dimensions which range from one hundred to several thousands
of meters. Example structures include very large microwave
reflectors, microwave antennas, platforms, solar energy
collectors, solar sails and telescopes. Such missions will
be economically feasible because of the availability of the
space Shuttle. Control systems design for LSS is a complex
and challenging problem because of high flexibility of LSS.
Pointing requirements dectate that the desired closed-loop
bandwidth be higher than modal frequencies of some of the
structural bending modes. In this paper, the problems
involved in attitude and shape control of LSS are discussed,
and some methods of designing stable, robust controllers for
LSS are presented. (Supported by NASA Contract NAS1-16126)

VISCOUS-CORE ANALYSIS AND INVISCID PREDICTION OF VORTEX-CORES OF LEADING AND TRAILING EDGE SEPARATIONS OF DELTA WINGS[+]. O. A. Kandil and L. Balakrishnan*, Dept. of Mech. Engrg. and Mecs., Old Dominion Univ., Norfolk, Va. 23508

The separated free-shear layers from the leading edges of a delta wing roll up spirally into two counter rotating vortex cores. These vortex cores (primary vortex cores) highly influence the aerodynamic characteristics of the wing over a wide range of angles of attack. In this paper, we present a realistic viscous-inviscid model for the wing and its vortex cores to predict the effect of the wing angle of attack and its aspect ratio on the vortex-core size. The final goal of this research work is to develop computer codes capable of predicting the wing aerodynamic characteristics, particularly near the angle of stall for steady and unsteady flows.

Viscous modeling is limited to the core flow only while inviscid modeling is adopted for the rest of flow region. Boundary-layer-like approximations are applied to the core flow and the resulting equations are solved by a finite-difference technique. Boundary conditions for the core model are obtained from the solution of the inviscid model. The inviscid model is solved by the Modified Nonlinear-Discrete method developed earlier by the senior author. Several numerical examples are presented for the steady flow about a delta wing of aspect ratio of unity.

[+]This work is supported by NADC, Warminster, Pa. under contract No. N62269-80-65-02024, Mr. M. Walters and Dr. K. T. Yen are tech. monitors.

ANALYTICAL STUDY OF HIGHLY SWEPT WINGS WITH LEADING-EDGE VORTEX FLAPS AND STRAKES. C. S. REDDY*. Mech. Engg. and Mechanics Dept., Old Dominion Univ., Norfolk, Va. 23508

The effect of leading-edge vortex flap deflection on the aerodynamic performance of a 74° delta wing is analytically studied using the free vortex sheet method developed by Boeing Aircraft Company under a contract with NASA Langley Res. Ctr. The longitudinal aerodynamic characteristics are computed and the vortex sheet shapes determined for various flap-up and flap-down situations. It is found that the effect of the vortex flap deflection is more dominant on the drag and the lift-to-drag characteristic than on the lift and pitching moment. By proper deflection of the flap, the drag can be increased or decreased, and this can be advantageously utilized during various flight regimes.

Also, the influence of the leading-edge sweep angles on the aerodynamic characteristics of a strake wing model is investigated employing the same method. The basic model considered here is a double arrow wing which has an 80° inboard sweep, 65° outboard sweep, pointed tip and 30° trailing-edge sweep. It is observed that lift and drag increase with increase in inboard and outboard sweeps. However, the lift-to-drag ratio is little effected by the changes in the sweep angles. The span-wise pressure distributions in the aft region of the wing are considerably influenced by the inboard sweep angle, whereas the outboard sweep angle appears to have no discernable effect on pressures in the wing forward region. (Aided by NASA grant NSG-1561)

SOME TESTING AND ANALYSIS TECHNIQUES APPLICABLE TO THE AERODYNAMIC ASSESSMENT OF AIRPLANES AND MISSILES, M. Leroy Spearman, Aerospace Technologist, Aeronautical Systems Division, NASA Langley Research Center, Hampton, VA 23665.

Some test and analysis techniques, both analytical and experimental, can be used to: (1) approach optimum configuration arrangements to achieve certain desired aerodynamic characteristics, and (2) assess the aerodynamic performance bounds for a specific configuration. The techniques include methods for both airplane and missile configurations to show trade studies that can be made and indicate the test data required. For example, when the dynamic pressure limits are known, nomographs can be developed to define the operational altitude and Mach number bounds for a configuration. When the maximum usable lift is known, nomographs can be used to determine the instantaneous normal acceleration as a function of altitude, wing-loading, and Mach number. The effect of stability level (or center of gravity location) can also be included. Among the trades that can be shown are the effects on turn radius of speed and normal acceleration from which some implications on air-to-air combat, and on missile-intercept capability, are apparent. Some test techniques, such as remote activation of control surfaces during the test run to trim the pitch, roll and yaw, provide savings in time and cost and the data more accurately simulates true flight conditions.

TWO-DIMENSIONAL TRANSVERSE INJECTION INTO A SUPERSONIC MAINSTREAM. G. O. Kraemer*, Graduate Research Assoc., Dept. of Mech. Eng. and Mech., O.D.U., Norfolk, Va, R. C. Rogers*, Aerospace Engineer, NASA-Langley Research Center, Hampton, Va., and S. N. Tiwari, Eminent Professor, Dept. of Mech. Eng. and Mech., O.D.U. Norfolk, Va.

An experimental investigation of the interaction of a sonic slot jet injected transversely into a Mach 2.9 air mainstream is being conducted. This investigation will examine aerodynamic features, such as the extent and nature of separated regions near the jet and wall static pressure distributions. Jet mixing downstream of the jet will be investigated by instream pitot pressure, static pressure, and gas composition profiles. Surface gas composition distributions in the separated regions near the jet will be obtained from surface taps. A prime objective of these tests is to provide data pertaining to the jet mixing and interaction suitable for comparison with an existing two-dimensional theoretical solution. The scope of the present test program is to inject nitrogen or helium gas at pressures of 5, 10, and 20 times the mainstream static pressure from two injector gap widths. The downstream flow field will be mapped by obtaining static pressure, pitot pressure, and gas composition profiles at three downstream stations. An overview of the experiment and typical results will be presented.

A SIMPLIFIED VORTEX LATTICE MODEL FOR POTENTIAL FLOW PAST A FUSELAGE. Jin-Yea Shu*, and John M. Kuhlman, Dept. of Mechanical Engineering and Mechanics, ODU, Norfolk, VA 23508

The Vortex Lattice representation of lifting surfaces and non-lifting bodies, for prediction of aerodynamic performance, has been well developed over the past thirty years. However, because the geometry of the general fuselage is fairly complicated, much computing time and computer memory is needed to obtain the circulation strength solution using the full influence matrix. In view of this, through the present technique of transformation to approximate the actual body by a bounding rectangular box, the solution is obtained easily with less computer cost, with little sacrifice in accuracy for slender fuselages. Actual boundary conditions are transformed to the rectangular box through use of slender body theory, using a concept previously applied for transonic wing-bodies. The development of the theory will be summarized, and results will be presented for an axisymmetric fuselage at zero angle of attack. (Aided by NASA grant NSG 1357.)

FIBER OPTIC DATA DISTRIBUTION CONCEPT FOR CIVIL AIRCRAFT. J. L. Spencer*, H. D. Hendricks*, and C. J. Magee*. NASA Langley Research Center, Hampton, Va. 23665

Langley Research Center, as part of its controls and guidance program, is developing technologies to make civil aircraft of the 1990-2000 period more efficient and safer. One of these technologies involves the use of fiber optics on board the aircraft for reliable distribution of data between the flight crucial computing system and the sensors and actuators. This presentation describes a fiber optic wavelength multiplexing concept for the data distribution which is more reliable and lower in weight than conventional wire systems. The system concept will be discussed, hardware components (semiconductor lasers, optical fibers, optical multiplexers, optical demultiplexers, and PIN detectors) will be described and the system benefits detailed. Data will be presented on the performance of a four wavelength system.

ANALYSIS OF AEROTHERMODYNAMIC ENVIRONMENT OF A TITAN AEROCAPTURE VEHICLE. S.N. Tiwari and H. Chow*, Dept. of Mechanical Engineering and Mechanics, Old Dominion University, Norfolk, Virginia 23508, and J.N. Moss, NASA Langley Research Center, Hampton, VA 23665

The extent of convective and radiative heating of a Titan entry body is investigated. The flow in the shock layer is considered to be axisymmetric, steady, laminar as well as turbulent, viscous, and in chemical equilibrium. The implicit finite difference technique is used to solve the viscous shock-layer equations for a 45-degree sphere cone at zero angle of attack. Different compositions for the Titan's N_2 - CH_4 atmosphere were assumed and results were obtained for the entry conditions specified by JPL. The results show that the amount of CN concentration in the shock layer gas determines the extent of radiative heating to the body. Radiative heating downstream of the stagnation point increases due to an increase in CN concentration. It is found that both the convective and radiative heating increases significantly as the N_2 concentration increases.

ELASTIC DEFORMATION EFFECTS ON AERODYNAMIC LOADS. Judith J. Watson.* NASA Langley Research Center, Hampton, Va. 23665

A series of wind tunnel tests has been conducted in the Langley Transonic Dynamics Tunnel to investigate the effects of oscillating control surfaces on unsteady aerodynamics. The tests were conducted on a high aspect-ratio, force/ pressure, supercritical wing model that was designed to be very rigid. This paper presents the results of an investigation of the deformations of the wing model during the tunnel tests and the effects these deformations have on the wing aerodynamics.

In the study a finite-element model (FEM) of the wing was developed and then, for conditions corresponding to wind tunnel test points, experimental aerodynamic loads and analytical aerodynamic loads were applied to the FEM. Comparisons were made between experimental loads and analytical loads for changes, along the wing span, in lift per angle of attack, in center-of-pressure locations, in bending deflections, and in torsional rotations.

The results from this study show good correlation between the analytical and experimental data. They also show that the deformations are quite small and that the experimental pressure data were not significantly affected by model deformations.

HIGH ALTITUDE, SOLAR POWERED PLATFORM. James W. Youngblood, NASA Langley Res. Ctr., Hampton, Va. 23665

An unmanned, high-altitude, solar-powered electric airplane is proposed. Remotely piloted from the ground, the propeller-driven craft obtains power for payload and propulsion from on-board solar energy collectors. Stored energy enables overnight flight, allowing the airplane to remain on station for up to months at a time. This unique capability could be exploited in design of long-duration reconnaissance, communications, and remote monitoring platforms for local or regional mission applications.

Theoretical performance is calculated such that 24-hour level flight is enabled at "equilibrium" altitude; i.e., excess solar energy, stored around midday, matches the energy required for overnight flight. Results are presented to illustrate enabling technology areas critical to vehicle development: (1) materials and structures for ultra-low airframe wing loading; (2) high efficiency aerodynamic components for low Reynolds number flight; (3) high specific energy storage devices.

The data illustrate effects of date, latitude, atmosphere transmissivity characteristics, and payload power requirements on vehicle performance (altitude and flight duration) and design requirements (e.g., efficiency and orientation of solar collectors, aerodynamic characteristics, and size of power train and energy storage systems). Airplane sizing data, in terms of wing area, are presented for representative payload mass and power requirements.

Agricultural Sciences

**Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University**

INFLUENCE OF RESTRICTED GROWTH AND ELEVATED CALCIUM AND PHOS-
PHORUS LEVELS ON FOOT, METACARPAL AND METATARSAL CHARACTERIS-
TICS OF CONFINEMENT-REARED SOWS. S. R. Arthur, E. T.
Kornegay, R. A. Barczewski, K. E. Webb, Jr., H. P. Veit and
D. R. Notter. Dept. of Animal Science, VPI & SU, Blacksburg,
Va. 24061
    Gilts which had previously been fed ad lib or 75% ad lib
intake and 100 or 150% NRC daily Ca and P levels from weaning
to 100 kg were selected for the reproductive study and fed a
balanced gestation-lactation diet. Foot and leg measurements
and subjective toe scores were taken 21 days postweaning for
three parities. Foot, horn and toe length and toe width were
measured on both front and rear feet. Bone samples were
taken from sows culled due to lameness or failure to breed
and from sows completing three parities. All toe measurements
(TM) increased over time. Outside TM were larger than inside
TM and rear TM were larger than front TM. Rear outside TM
were always larger than front outside TM. Toe volumes and
areas were smaller for previously restricted-fed sows through
three parities. Pad and horn scores improved over time with
the hind outside toe having the least desirable score through-
out all three parities. Sows previously fed 150% Ca and P
had longer and wider metacarpals and metatarsals that were
thicker at the narrow and perpendicular dimensions. Bones of
sows previously fed 150% Ca and P contained more ash and less
fat. Previously restricted-fed sows had metatarsals that
contained more calcium and more P as a percent of dried fat-
free bone with more ash and less fat than metatarsals of the
previously ad lib-fed sows.

THE EFFECT OF TWO LEVELS OF CALCIUM AND PHOSPHORUS AND ENERGY
INTAKES ON GAIT PARAMETERS IN SOWS OVER THREE PARITIES. R.
A. Barczewski[*], E. T. Kornegay, S. R. Arthur, A. J. Lepine[*],
A. F. Harper[*], H. P. Veit[*], D. R. Notter, H. R. Thomas and
J. W. Knight. VPI & SU, Blacksburg, Va. 24061
    A study was conducted to determine the effects of early
nutrition (ad lib vs 75 ad lib and 100 vs 150% of NRC daily
Ca and P) on gait characteristics of sows over three parities.
Gilts were maintained on these treatments throughout the
growing period. At 100 kg, all gilts were placed on a stan-
dard (14% crude protein) ration. Approximately 21 days post-
weaning the sows were filmed with 16 mm film while walking on
a treadmill. Film was edited on a Lafayette film analyzer to
identify the most natural gaits and measurements were taken.
No differences were observed in distance to arc point and
angle at the flex. Findings indicate that over time sows be-
came longer, taller and deeper in girth (P<.01). Increases
were also observed in height of arc point (P<.05) and height
of front foot (P<.001), whereas, front (P<.001) and rear
(P<.06) pastern angles, height of rear foot (P<.03) and angle
of hock (P<.002) decreased over time. Previously ad lib fed
sows were taller, 72.1 vs 70.9 cm, (P<.001) than restricted
fed sows, while sows fed 100% NRC Ca and P during the growing
period were shorter, 70.5 vs 72.5 cm, than sows fed the 150%
Ca and P diets. There was a tendency (P<.08) for sows pre-
viously fed ad lib intakes to be straighter in their pasterns
than restricted fed animals.

RELEASE RATE OF PROGESTERONE FROM INDWELLING ELASTOMER
IMPLANTS IN SWINE. N. L. Barber[*], J. W. Knight and F. C.
Gwazdauskas. Depts. of Animal and Dairy Science, VPI&SU,
Blacksburg, VA 24061
    Previous studies by our group have demonstrated that
daily subcutaneous injections of exogenous progesterone (P)
and estrone (E) in a 2000:1 ratio elicited beneficial
effects on porcine placental growth and development when
administered during discrete periods of early gestation.
However, daily injections represented a labor inefficient
method of delivery, subjected the gilts to considerable
stress and resulted in a surge of steroids rather than a
more physiological rate of release. Investigations cur-
rently in progress utilize an indwelling elastomer implant
approximately 100 x 3 mm containing 2 g P/1 mg E. This
dose level was determined based upon this preliminary study
examining doseage level/implant (2 g P/1 mg E vs 4 g P/2 mg
E, no. of implants (1 vs 2) and total doseage level/gilt (2
g P/mg E, 4 g P/2 mg E, 8 g P/4 mg E). Four ovariectomized
gilts were utilized. Systemic P concentrations were measured
daily and over a consecutive 24-hr period under each treat-
ment regime. It was concluded that 1 implant containing
2 g P/1 mg E represented the most efficient treatment. The
release rate from one 2 g P/1 mg E implant of 16.67 ± 1.71
ng/ml approximated systemic P concentrations during preg-
nancy. No compensatory increase was demonstrated when
either number of implants or doseage/implant was doubled.
Variation in release over a 24-hr period was observed.

THE DEMAND AND ALLOCATION OF U.S. APPLES WITH SOUTHEASTERN
IMPLICATIONS. H. S. Baumes, Jr., Dept. of Ag. Econ.,
Virginia Tech., Blacksburg, VA 24061
    The objectives of this paper are to theorize and
estimate an econometric model of the demand and allocation
structure of the U.S. apple sector. The apple sector is
disaggregated into fresh and processing markets and grower
and retail market levels are specified. An impact multi-
pler analysis is included.
    Given the estimated model a regional pesticide with-
drawal scenario is discussed. On a regional basis total
utilization and allocation of apples to the fresh market
deviate slightly from the national average. Price impacts
resulting from a national production loss and a production
loss in the southeast are very similar. For each loss of
100 million pounds of production prices increase .14, .07,
.22, and .05 cents per pound for retail market fresh apples,
farm level fresh apples, retail market processing apples,
and farm level processing apples, respectively.

A SELECTION PROGRAM FOR IMPROVING SOW PRODUCTIVITY. K. P. Bovard, D. C. Almes* and C. R. Cooper*. Dept. of Animal Science and Computing Center, VPI & SU, Blacksburg, VA 24060.

In September 1980, Virginia Tech received a copy of a computer program to evaluate sow productivity, based on litter size--both number born alive and number raised to weaning--and litter weight at about 21 days of age. The program was developed by Keith Irvin of Ohio State University, and was written for use with the SAS (Statistical Analysis System) library of programs applied to the IBM-370. In order to calculate each sow's productivity index, the program requires identification of each sow, her sire, and the sire producing each of her litters. Performance data cited above and farrowing data are entered for each litter of a contemporary group--all litters born in a 4-6 week period. Summary results provide a ranking of 1) sows in the most recent contemporary group, 2) all sows with records in the system, 3) sow families as defined by the producer, and 4) sires of sows. The program is a tool for purebred and commercial breeders to improve litter size and litter weight.

BREED OF SIRE EFFECT ON CONCEPTION, CALF SURVIVAL AND COW PRODUCTIVITY. R. A. Brown*, T. J. Marlowe and E. A. Tolley, Dept. of Animal Science, VPI&SU, Blacksburg, Va 24061

Sire breed effects were evaluated on 581 Angus cows and 1378 Hereford cows at two locations. Angus (A), Hereford (H), Shorthorn (Sh), Brown Swiss (BS), Holstein (F) and Charolais (C) sire breeds were involved. Growth parameters include average daily gain (ADG), actual weaning weight (WWT), and adjusted 205-day weight (ADJ 205). Reproductive parameters are comprised of perinatal mortality (death w/in 72 hr), total calf mortality, % open cows, % dead or culled cows, and % weaned. Growth data were analyzed using Harvey's least squares procedure. The model included sire breed, year, sex, dam age, sire x year and age. The reproductive parameters were analyzed using Harvey's Least Squares Analysis of Discrete Data. The model included sire breed, year, dam age and sire x year. Using kg of calf weaned per cow exposed, C ($191 \pm .05$) were superior to F ($172 \pm .06$) and A ($162 \pm .06$) when sired to A cows at Southampton. Sire breed, year, sex and dam age were highly sig (P < .001) for ADG, WWT and ADJ 205. Sire breed was not sig for any reproductive parameters. In the H base cow herd at State Farm, sire breeds ranked by kg calf weaned per cow exposed were F ($145 \pm .006$), C ($133 \pm .008$), Sh ($133 \pm .01$), BS ($123 \pm .01$), H ($117 \pm .004$) and A ($102 \pm .01$). All sources of variation were highly sig (P < .001) for growth parameters. Sire breed was sig (P < .01) only for % weaned in reproductive performance characteristics.

SUPPLEMENTAL BIOTIN FOR GILTS AND SOWS HOUSED IN TOTAL CONFINEMENT: A PRELIMINARY REPORT. K. L. Bryant*, E. T. Kornegay, J. W. Knight and K. E. Webb, Jr., Dept. of Animal Science, VPI & SU, Blacksburg, VA. 24061

One hundred and sixteen crossbred gilts were utilized in a 2 x 2 factorial design to evaluate the effects of corn (C) and wheat (W) diets supplemented with either 0 (-B) or 440 ug/kg (+B) biotin on reproductive performance, foot lesions and hair characteristics of gilts and sows housed in total confinement for two parities. Conception rates, although not significantly (P>.10) different, favored C and +B females. Days to estrus following weaning were lower for C and +B sows. Although differences were not significant (P>.10), all farrowing and lactation criteria favored the +B females. Females fed C diets had heavier pigs at birth (P<.03) and 21 days (P<.04) compared with W-fed females. Plasma biotin concentrations (PBC) were not different (P>.10) for C and W diets; however, PBC were higher (P<.008) at all sampling times for +B females. Females consuming W diets had a higher (P<.001) incidence and severity (P<.11) of heel-toe erosion than females fed C diets. There was a trend for reduced incidence of heel cracks for +B females, while the severity of these heel cracks were reduced (P<.04) by B supplementation. The incidence of heel-toe junction cracks and side wall cracks were lower (P<.03) for +B females. Biotin supplemented females had more hairs per cm^2 (P<.03) and better hair scores (P<.001) compared to -B females.

MODELING DIAMETER DISTRIBUTION WITH A BIMODAL PROBABILITY DENSITY FUNCTION. Q. V. Cao*. Biometrics Section, Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

Diameter distributions can be either unimodal or bimodal. Whereas unimodal probability density functions (pdf) have been often used to model diameter distributions, little work has been done concerning bimodal pdf's. A new probability density function which can be either bimodal or unimodal was developed.

Let Z be a standard normal variable and X be a positive random variable. Using the transformation

$$Z = g(X) = \begin{cases} g_1(X) = a + b \ln(X), & 0 < X \le t, \\ g_2(X) = p + q\, c^X, & t < X < \infty, \end{cases}$$

where $g_1(x)$ and $g_2(x)$ are conditioned such that $g(x)$ is smooth and continuous at the join point t, the pdf for X is derived:

$$f(x) = \begin{cases} (2\pi)^{-1/2}(b/x)\, \exp\{-[a+b\ln(x)]^2/2\}, & 0 < x \le t, \\ (2\pi)^{-1/2}(b/t)\, c^{x-t}\, \exp\{-(p+qc^x)^2/2\}, & t < x < \infty, \\ 0, & \text{otherwise} \end{cases}$$

where $q = b/[tc^t \ln(c)]$ and $p = a + b \ln(t) - qc^t$.

An iterative procedure was developed to obtain the maximum likelihood estimators for a, b, c, and t.

INFLUENCE OF BREEDING, SEX AND AGE ON PERFORMANCE OF CATTLE WINTERED ON POOR QUALITY HAY. Michele Cochran*, W. H. McClure*, Isabelle Ortigues*, K. P. Bovard and J. P. Fontenot. Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Sixty steers and heifers of variable age, weight and breeding were wintered on coarse predominantly tall fescue hay alone and with different protein supplements. All cattle were implanted with Ralgro. Shrunk weights were taken initially, after 71 days and at the end of the trial (119 days). Age varied from 296 to 662 days and initial weights varied from 173 to 365 kg. The types of breeding were straightbred Angus, Simmental-Hereford-Angus cross and three-way and two-way British breed crosses. Daily gains were highest for the three breed (.28 kg) and lowest for the two breed (.19 kg) crosses. Performance was intermediate for the other cattle. No marked differences were observed in daily gain between steers and heifers. The values were .16 kg for steers and .17 kg for heifers. Daily gain was .09 kg for calves, compared to .15 and .19 for yearlings and 2-year-olds, respectively. However, the statistical correlation was low between age at the beginning of the feeding period and daily gain. Initial weight was correlated with daily gain. Daily gains were .08, .17 and .20 kg for cattle with initial weights of 173-213, 229-295 and 296-365 kg, respectively. The correlation coefficient was .33 (P<.01).

METHOMYL: ITS PLACE IN AN IPM PROGRAM FOR APPLES. Paul J. David and Robert L. Horsburgh, Dept. of Entomology, Winchester Fruit Res. Lab., VPI & SU, Winchester, VA 22601.

For many orchard pests, especially leafrollers, the egg stage is the weakest point in the life cycle. Methomyl, used as an ovicide/larvicide, can be an effective control measure for many of these pests. Being a short residual insecticide, the compound can be applied at the optimum time for maximum effectiveness and minimal effect on the parasite/predator complex. Laboratory tests on the eggs of pest and beneficial insects illustrated that methomyl can be applied at a rate of 0.26 g AI/1, one-half the recommended rate, and still provide adequate control of pest species with minimal effects on some of the more important predatory insects. A predictive, temperature-driven model is being developed to predict pest development. Once the model is validated, ovicide/larvicide sprays using methomyl can be accurately timed for optimal effectiveness.

PRELIMINARY STUDIES ON THE PHENOLOGY OF THE EUROPEAN CORN BORER, OSTRINIA NUBILALIS (HUBNER) (LEPIDOPTERA:PYRALIDAE), IN WESTERN VIRGINIA. Joseph L. Despins* and James E. Roberts, Sr., Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Ostrinia nubilalis (Hubner) has long been a pest of corn in Virginia. During the 1977-79 growing seasons, first generation O. nubilalis became especially pestiferous. The purpose of this research was to measure the development of this insect in the field through the accumulation of heat units (degree-days). Such information is necessary for the timely initiation of scouting activities in the western regions of the state.

Spring pupae were first collected, and pupation peaked and ended at 89, 422 and 579 degree-days, respectively. Peak spring moth flight and peak oviposition occurred with an accumulation of 497 degree-days. Initiation of summer moth flight, peak summer flight and peak late summer flight appeared with temperature accumulations of 935, 1163 and 1714 degree-days, respectively.

FEASIBILITY STUDY OF OILSEED SUNFLOWER PRODUCTION ON LANDS RECLAIMED FROM THE STRIP-MINING OF COAL. R. D. Fell and D. M. Orcutt. Dept. of Entomology and Dept. of Plant Pathology and Physiology, VPI & SU, Blacksburg, VA 24061.

Three varieties of oilseed sunflowers (Northrop King; Sunbred 212, 254 and 265) were planted on recently reclaimed lands at a site in Wise County, Va. The plants were sown at a density of 54,000 plants/hectare in a research plot measuring 15x46 m. Ground preparations were minimal. Plant growth, seed production and seed oil content were determined for each variety. The effects of a plant growth regulator (Cycocel) and the varietal needs for cross pollination were examined also. The PGR was applied at a rate of 12 kg AI/hectare when plants reached a height of 15-20 cm. The needs for cross pollination were examined by covering flower heads during bloom with plastic screen bags and comparing the resultant seed production with open pollinated plants.

Large differences in growth and productivity were found between the varieties tested. The most productive variety was S-212, followed by S-254 and S-265, respectively. The estimated per hectare yield (dry wt.) of S-212 was 988 kg. Mean seed oil content was 17.8 mg/seed (48% by wt.) for S-212 and 5.90 mg/seed (31% by wt.) for S-254. No significant differences in productivity were noted after treatment of plants with Cycocel or between open-pollinated and bagged heads. The lack of significant differences in the pollination treatments may have been partially due to the low numbers of pollinators observed in the field (< 7 bees/100 flowering heads).

EVALUATION OF GRASS- AND GRAIN-FED BEEF BY TRAINED MEAT PANELISTS AND BY CONSUMERS. W. V. Fredric*, K. P. Bovard, P. P. Graham*, J. P. Fontenot and R. F. Kelly*. Departments of Animal Science and Food Science and Technology, VPI & SU, Blacksburg, Va. 24061.

For four successive years, steers from an experiment comparing forage management systems were slaughtered and carcass traits and composition recorded on each animal. Seven forage-grain combinations were compared, with six steers per treatment fed at each of two locations, Glade Spring and Middleburg. At slaughter, rib and loin sections were fabricated. Sample roasts were cut from the 6-7-8 rib section and sent to a cooperator (Beltsville) for evaluation by a professionally trained taste panel (PTP). Steaks were cut from the loin section, identified and packaged in pairs, one from each of two treatments, i.e., 1-2, 1-3, 1-4,...5-7, 6-7. These pairs were later evaluated by a panel of local consumers (CTP) stratified by age and socio-economic status. The PTP rated roasts from cattle receiving grain more palatable than those from cattle fed forage only. The CTP generally preferred loin steaks from grain-fed cattle to those from cattle receiving forage only; but the preferred steaks were less acceptable to the consumers than comparable cuts available commercially.

ANIMAL PROTEINS WITH AND WITHOUT TRYPTOPHAN AS PROTEIN SUPPLEMENTS FOR GROWING SWINE. K. M. Elmer*, C. C. Brooks and E. T. Kornegay, Dept. of Animal Science, VPI & SU, Blacksburg, Va. 24061 and W. I. Hugh*, Dept. of Animal Science, Univ. of Hawaii, Honolulu, Hi. 96844

Thirty growing pigs (6/treatment) were used in a feeding trial to study the influence of supplemental tryptophan for tuna meal and meat and bone meal diets on growth and bone mineralization. Dietary treatments were: (1) corn-soybean meal (CS), (2) corn-tuna meal (CT), (3) CT plus .075 tryptophan (CTT), (4) corn-meal and bone meal (CM) and (5) CM plus .075% tryptophan (CMT). Pigs were ad libitum fed from an initial weight of 44 lb to a final weight of 185 pounds. Radius and tibia were used for bone analysis. Pigs fed CS diets grew faster (P<.001) than pigs fed CT, CTT, CM and CMT diets (1.69 vs 1.30, 1.43, .98 and 1.48 lb, respectively). Tryptophan improved gains (P<.001) of pigs fed both CT and CM diets. Dry matter percentage of the radius and tibia (diaphysis and proximal ephiphysis) was less for pigs fed CS compared to the other diets. Radius volume (ml) was greater for pigs fed CS compared to the other diets, but was not different between diets for the tibia. Breaking strength of both radius and tibia was increased when tryptophan was added to CT and CM diets with a greater response when added to CM diets. Dry matter percentage of the ephiphysis of the tibia was decreased when tryptophan was added to the diets, but was not different for the radius. Pigs fed the CS diet had a lower dry matter percentage of the radius ephiphysis than pigs fed the other diets.

CALIBRATION OF SWEEP NET SAMPLING FOR POTATO LEAFHOPPER IN ALFALFA. S. J. Fleischer*, W. A. Allen, J. M. Luna*, and R. L. Pienkowski. Dept. of Entomology, VPI&SU, Blacksburg, VA 24061.

A calibration equation is developed that relates mean pendular sweep net catch of potato leafhoppers in a given field to the absolute density. A comparison of 3 absolute density techniques showed that the D-Vac^R, and a modified Echo^R suction sampler operated with a lightweight drop trap yielded accurate estimates upon which the calibration equation was based. The D-Vac did not need calibration, and sampling several meters ahead of the sampler to avoid disturbing the leafhoppers gave no measurable advantage. Multiple regression with crop and environmental parameters did not improve the fit of the calibration. Robust regression helped identify outliers that were related to harvesting practice or uniformity of alfalfa stand. Mean sweep net catch (y) was a univariant linear function of mean absolute density (x) by the formula x = 18.5y, with an R^2 of 83%. Analysis of the frequency distribution generally followed a Poisson series, and deviations from this pattern were related to those fields identified as outliers.

MAGNESIUM METABOLISM IN SHEEP FED DIFFERENT LEVELS OF SOLUBLE CARBOHYDRATE AND POTASSIUM. S.A. Giduck*, J.P. Fontenot, J. Herbein*, L.W. Greene* and K.E. Webb, Jr.* Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

Two metabolism trials were conducted with 12 wether lambs equipped with abomasal and ileal cannulae. A 2x2 factorial arrangement was used with 3 and 23% soluble carbohydrate and .6 and 4% potassium (K), dry basis. Each trial consisted of a 10-day preliminary period followed by a 7-day collection of feed, feces and urine and a 6-day sampling of feed, abomasal and ileal fluid, and feces. Chromic oxide was used to measure flow through the digestive tract. Magnesium absorption was not affected by level of soluble carbohydrate. High K decreased magnesium absorption (P<.01). Urinary magnesium excretion decreased at the high K level (P<.01). The primary site of magnesium absorption was preintestinally. High K tended to depress magnesium absorption in this area, but had no effect in the intestines. High soluble carbohydrate had no effect on preintestinal magnesium absorption, but tended to increase magnesium absorption in the large intestine. Increased K in the diet resulted in an increase in K absorbed, (P<.01). The primary site of K absorption at the low level of K was the small intestine, but at the high level the stomach was important also. Serum magnesium and calcium tended to be depressed at the high K level. High dietary K increased serum K (P<.05), but high soluble carbohydrate tended to decrease it.

SITE OF MAGNESIUM ABSORPTION IN STEERS FED HIGH LEVELS OF POTASSIUM. L.W. Greene*, J. P. Fontenot and K. E. Webb,Jr.* Dept. of Animal Science, Va. Polytechnic Inst. and State Univ., Va. 24061.

Six crossbred steers, average initial weight, 261 kg, were surgically equipped with abomasal and ileal cannulae to determine the site of magnesium absorption. Three metabolism trials were conducted with a 10-day preliminary period, a 7-day collection of feed, feces and urine and a 6-day sampling of feed, feces, abomasal and ileal fluid. Three levels of potassium (K) (.6, 2.4 and 4.8%, dry basis) were fed in a randomized block design. Chromic oxide was used as an indicator to measure flow through the digestive tract.

Magnesium (Mg) absorption decreased linearly (P<.05) when high levels of K were fed. The primary site of Mg absorption was in the preintestinal region, followed by a net secretion into the small and large intestine. When the high level of K was fed, preintestinal Mg absorption decreased (P<.05), smaller amounts of Mg were secreted into the small intestine and serum Mg was depressed.

Potassium absorption and retention increased (P<.05) with increasing levels of K. The intestinal regions were the primary sites of K absorption when the low level of K was fed, but with the higher levels of K intake, the preintestinal region was also an important site of absorption.

Magnesium absorption in steers was similar to those observed previously in sheep when high levels of K were fed.

EFFICACY OF VIRGINIAMYCIN AND A LACTOBACILLUS CULTURE IN SWINE DIETS. A. F. Harper*, E. T. Kornegay, K. L. Bryant* and H. R. Thomas. VPI & SU, Blacksburg, Va. 24061

Six trials using 600 crossbred pigs were conducted to evaluate the addition of virginiamycin (VIR) and lactobacillus (LAC) to swine diets. VIR was added at a level of 11 mg/kg of diet and LAC at a level of 1000 mg/kg in starter diets and 500 mg/kg in grower and finisher diets. In three starter tirals, daily gain, daily feed intake, and feed efficiency were not significantly different between dietary treatments. During the starter phase of a fourth trial, pigs grew faster when fed diets containing VIR or chlortetracycline, penicillin and sulfamethazine (ASP 250) compared with pigs fed the control or a LAC containing diet. During the grower and finisher phase and overall for this trial, daily gain and daily feed intake were lower for pigs fed the LAC containing diet than for the ASP 250 containing diet with intermediate values observed for the control pigs and pigs fed the VIR containing diet. In two grower-finisher trials where VIR and LAC were compared in a 2 x 2 factorial arrangement of treatments, daily gain and feed intake were greater for pigs fed diets containing VIR. In one of the two trials, a significant VIR times LAC interaction was observed; in the absence of VIR, daily gain and feed intake were improved when LAC was added to the diet, but they were depressed in the presence of VIR. Feed per gain ratios were not significantly different between treatments. These data suggest that VIR and LAC should not be used in combination.

AN EXAMINATION AND CHARACTERIZATION OF TRUE HERMAPHRODISM AND MALE PSEUDOHERMAPHRODISM IN SWINE. J. W. Knight, Dept. of Animal Science, VPI&SU, Blacksburg, VA 24061

Two male pseudohermaphrodites (PH) and 2 true hermaphrodites (H) were examined endocrinologically, histologically and morphologically. Indwelling catheters were surgically placed into the anterior vena cava of each to enable frequent blood sample collection. Blood samples were taken either every 30 min (PH) or 60 min (H) for a consecutive 24 hour period, as well as once per day for approximately 3 weeks to ascertain an endocrine profile. Hormones measured were testosterone (T), progesterone (P), glucocorticoids (GC) and luteinizing hormone (LH). Repeated (every 15 or 30 min) blood samples were also collected pre- and post-administration of various exogenous hormone challenges to measure their endocrine response capabilities. Endocrine data includes the following: for PH 1, diurnal T ranged from .5-2.6 ng/ml with 2 major peaks at 10-hr intervals; PH 2 had T values of .2-1.0 ng/ml with 2 major peaks at 16-hr intervals and CC concentrations of 5-63 ng/ml; H 1 had daily T values of .2-2.7 ng/ml over the 3 week sampling period, P values of .2-16.9 ng/ml, suggesting cyclicity and LH levels <1 ng/ml; H2 has T levels of .1-1.9 ng/ml, P values of .1-1.9 ng/ml and LH concentrations of <1 ng/ml. Both PH had only testicular (no ovarian) tissue, but possessed all other components of both male and female reproductive traits. Both H had a testis as the right gonad and ovary as the left gonad and varying amounts of male and female reproductive tract development.

PRECIPITATION AND AIR TEMPERATURE EXTREMES SINCE 1933 AT HOLLAND IE STATION. D. L. Hallock* Tidewater Res. and Continuing Education Ctr., VPI&SU, Suffolk, Va. 23437.

Considerable variance has occurred in air temperatures and precipitation during the past 48 years. The highest average monthly maximum temperature was 92°F which occurred July 1942 and 1952. The lowest average monthly maximum was 40° which occurred Jan. 1940. Daily maximum temperatures attained 105° in June 1952 and July 1942. The highest average monthly minimum temperature of 72° occurred July 1949 whereas the lowest (18°) occurred Jan. 1940. Daily minimum temperatures were as low as -3° in Jan. 1940 and Feb. 1936. The average distribution of rainfall is excellent for crop production. Total monthly rainfall has varied from 15.57 in. in August 1949 to only 0.21 in. in Sept. 1958. Annual rainfall has varied from 63.49 in. in 1949 to 33.40 in. in 1980, the driest year on record at this Station. The highest recorded rainfall for any day was 6.41 in. (1949). For the June to Aug. period, the highest rainfall of 32.58 in. occurred in 1949 and the lowest 4.28 in. in 1980. Normal rainfall for this period is 16.32 in. Annual snowfall was highest ever during 1980, being 34.5 in. The 48-year mean is 7.5 in. There have been 8 years with less than 0.5 in. of snow during these 48 years. Extremes for killing frosts (32°F) are Oct 2 (1947) and Nov. 15 (1938) or Mar. 15 (1935) and May 11 (1947, 66). The average dates are Oct. 20 and April 15, giving a frost-free (+32°) season of ca 195 days.

SYNERGISTIC INTERACTION OF TEBUTHIURON WITH ALACHLOR AND METOLACHLOR IN CORN IN THE PRESENCE OF THE HERBICIDE ANTIDOTE R-25788. K. K. Hatzios*. Dept. of Plant Pathology and Physiology, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

Combination treatments of the herbicide tebuthiuron ($\underline{N}$-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-$\underline{N}$,$\underline{N}$'-dimethylurea) with the herbicides alachlor [2-chloro-2',6'-diethyl-$\underline{N}$-(methoxymethyl)acetanilide] and metolachlor [2-chloro-$\underline{N}$-(2-ethyl-6-methylphenyl)-$\underline{N}$-(2-methoxy-1-methylethyl)acetamide] in the presence of the herbicide antidote R-25788 (2,2-dichloro-$\underline{N}$,$\underline{N}$-diallylacetamide) interacted synergistically when applied to corn ($\underline{Zea\ mays}$ L., cv. 'Pioneer 3780') under greenhouse conditions. Alachlor and metolachlor were applied preplant incorporated at rates of 1.12, 2.24, 4.48, and 6.72 kg/ha, all combined with 0.56 kg/ha of R-25788, and they were evaluated against 0.28, 0.56, and 1.12 kg/ha of preemergence applications of tebuthiuron. Shoot dry weight and shoot height were the parameters measured and the synergistic interactions were evaluated by the methods of orthogonal comparisons and Colby. It is suggested that tebuthiuron may act as an inhibitor of a microsomal enzyme system that is possibly involved in the metabolism of the acetanilide herbicides alachlor and metolachlor in corn. This action of tebuthiuron may counteract a possible stimulatory effect of the antidote R-25788 on this enzyme.

CITRIC ACID FOR WEANED PIGS. E. T. Kornegay and K. L. Bryant.* Dept. of Animal Science, VPI & SU, Blacksburg, Va 24061

Citric acid which has been suggested as having a beneficial influence on feedlot performance of growing swine was evaluated in two trials using weaned pigs. In trial 1, four pens of pigs (5/pen) averaging 16.2 lb were fed each of the following diets: (1) basal, (2) basal plus 2% citric acid and (3) basal plus 5 lb/ton of chlortetracycline, penicillin and sulfamethazine (ASP 250). In trial 2, two pens of pigs (6/pen) averaging 12.9 lb were fed a basal diet and a diet with 2% citric acid. Pigs were on test for six weeks in both trials. A 22% crude protein corn-soybean meal diet containing 10% dried whole whey was fed from weaning until pigs in a pen averaged 15 lb, a 20% protein diet was fed to 25 lb, and an 18% protein diet without the whey was fed for the remainder of the test. Feed and water were offered ad libitum. In trial 1, daily gain and feed intake were greatest for pigs fed the diet containing ASP 250, intermediate for pigs fed the diet containing citric acid and lowest for pigs fed the basal diet. Feed per gain, although not statistically different, favored pigs fed citric acid and ASP 250. In trial 2, pigs fed citric acid grew faster (P<.05) and consumed a nonsignificant greater amount of diet. As in trial 1, feed per gain in trial 2 favored pigs fed the diet with citric acid. In summary, 2% citric acid added to starter diets improved feed intake and feed efficiency which resulted in a faster growth rate.

DEVELOPMENT OF FOOT, LEG AND TOE CHARACTERISTICS OF BOARS FED REDUCED ENERGY LEVELS AND ELEVATED MINERAL AND VITAMIN LEVELS A. J. Lepine*, E. T. Kornegay, D. R. Notter, H. P. Veit, J. W. Knight, K. L. Bryant*, H. S. Bartlett* AND R. A. Barczewski*. VPI & SU, Blacksburg, Va. 24061

Eighty crossbred boars were used in a 2 x 2 factorial design to evaluate the effects of treatments (ad lib vs 75% of ad lib intake and 100 vs 150% of NRC minerals and vitamins) on foot and leg measurements and subjective toe scores taken at approximately 28, 120, 210, 290 and 330 days of age. Randomly selected boars were necropsied at 15 day intervals starting at 120 days of age. Length and width of front and rear inside and outside toes, length of metacarpal, metatarsal, tibia and ulna, and circumference of carpal and tarsal joints were large for ad lib-fed (AL) compared with restricted-fed (RT) boars when compared at a similar age; the reverse was observed when these parameters were compared on an equal weight basis. Elevated mineral and vitamin levels had no effect on the above parameters. Pad and horn scores were generally not affected by energy or mineral and vitamin level, although after 120 days, scores were slightly more favorable for boars fed 100% NRC minerals and vitamins. Pad and horn scores were generally higher (less favorable) for outside compared with inside toes of both front and rear feet. Outside pad scores increased to about 210 days and then remained similar for the remainder of the test; inside pad scores tended to decrease over time. Horn scores were low for both inside and outside toes of both front and rear feet, but were always much lower for the inside toes.

PERFORMANCE COMPARISON OF STRAIGHTBRED, SINGLE CROSS AND THREE-WAY CROSS COWS AT THREE LOCATIONS. Thomas J. Marlowe and Elizabeth A. Tolley, Dept. of Animal Science, VPI&SU, Blacksburg, Va. 24061

Three cow types were compared at three locations based on 518 matings to same kind of bulls for two calf crops. Stat model included cow type, location, year, sex, cow age, calf age and interaction of CT x Loc, CT x Yr and Loc x Yr. All variables significantly influenced weaning weight except CT x Yr interaction. R^2 = 0.63. Location (herd) had a major effect on both cow and calf performance. % open cows were 2.9 at Bland, 17.0 at Hanover and 18.6 at State Farm. Corresponding calf losses were 11.1, 15.7 and 13.0%; likewise, % calves weaned were 85.4, 70.4 and 69.4. Calves graded lower and were thinner at Hanover with Bland calves intermediate. Corresponding lb calf wn/cow exposed were 381, 238 and 150 lbs. No difference in 2WX and 3WX cows, both of which were superior to SB cows in calf wean wt but not in % calf crop wn. % cows open were 5.1, 14.8 and 13.4; % calf loss was 14.7, 10.2 and 13.6; and % calf crop wn was 78.1, 75.9 and 74.8 for SB, 2WX and 3WX, respectively. Corresponding wean wts were 403, 440 and 444 lbs and lb calf wn/cow exposed were 315, 334 and 332 lb. There was no difference in grade or condition score due to cow type.

BIOLOGICAL STUDIES OF CEUTORHYNCHUS PUNCTIGER GYLL. (COLEOPTERA: CURCULIONIDAE), A DANDELION SEED-FEEDING WEEVIL. T. J. McAvoy* and L. T. Kok. Dept. of Entomology, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061

Studies on the field biology of Ceutorhynchus punctiger, a weevil found infesting dandelions in Alleghany, Augusta, Frederick, Grayson, Highland, Montgomery, Pulaski, and Warren counties, were conducted during April and May in 1979 and 1980 in Blacksburg, VA. Dandelion growth stages were distinguished by grouping them in twelve categories (1-12). Eggs, up to 2.1/bud, were observed during the first week of April when the rays of the closed bud were still white (2). There were three larval instars. First instars were initially found in the 2nd week of April when the bud's outer sepals were open and the stem not elongate (4). Second instars were first collected during the 4th week of April when the flower had opened (6) and third instars were found when the flower was closed and the rays were dry and brown (8). All immature stages were collected up to but not after the 2nd week of May when the seed head opened and the seeds were exposed (10). The three instars averaged 6, 5, and 17 days and the pupal stage 22 days; larval head capsule size was 0.35, 0.50, and 0.67 mm and body length was 1.15, 2.07 and 3.38 mm for the three instars, respectively. Development from egg to adult emergence was 50 days. Seed consumption/larva was 22.8 $\pm$ 10.2 from a mean of 162.8 $\pm$ 40.5 dandelion seeds/head.

VIRGINIA'S FRESH APPLE MARKETS. J. Love* and H. S. Baumes, Jr., Dept. of Ag. Econ., Virginia Tech., Blacksburg, VA 24061

Virginia apple production has average 411 million pounds, annually since 1964. In 1980, Virginia produced 390 million pounds. In 1979, 470 million pounds were produced, of which 140 million pounds (30%) went for fresh market utilization. Since 1964, an increasing proportion of VA fresh production has been marketed within the state – up to 34% of the 1979-1980 crop. The remaining two-thirds of fresh production has been marketed to other states, principally in the East and South.

Eighty to 90% of VA fresh apples which are shipped to other states go to 12 major cities. The top four cities are (have been) Atlanta, Baltimore-Washington, Miami, and New York. A descriptive analysis was presented of changes in the total fresh apples received by these cities and the impact of other contributing states on the competitive position of VA.

INFLUENCE OF COW TYPE ON COW AND CALF PERFORMANCE. T. J. Marlowe, W. E. Burgess* and W. H. Cillette*, Dept. of Animal Science, VPI&SU, Blacksburg, and Southampton Correctional Center, Capron, Va.

Cow types compared were Angus (A) producing either straight (AA) or crossbred (AX) calves, Charolais x Angus (CA), Holstein x Angus (FA) and two 4-breed composites. Both composites were 1/4 A, 1/4 Hereford (H), 1/4 Simmental (S) and either 1/4 Charolais (C) or 1/4 Holstein (F). All cows were bred to AA bulls for 1st calf. Thereafter, half of AA and all CA and FA cows were bred to SH bulls and 4-way cows (SHCA, SHFA) to 4-way bulls. All cattle were treated alike. Avg. age of AA, AX, CA and FA cows was older than for 4-way cows. Based on 661 matings over 6 calf crops, overall calving % was 89.2, ranging from 86% for AX to 92.5% for SHFA. 205-day weight ranged from 421 lb for AA to 546 lb for SHFA. Lb calf weaned/cow exposed ranged from 364 for AA to 505 for SHFA. All crossbred (XB) cows outperformed straightbred (SB) cows, with SHFA composite superior to all others. FA cows were superior to CA cows (39 lb/cow exp); 4-way (SHCA, SHFA) were superior to single cross (CA, FA) by 33 lb; and SHFA superior to SHCA by 32 lbs. Best composite (SHFA) beat AA cows by 141 lb/cow exposed.

TRAP CROPS FOR CONTROLLING SOYBEAN INSECT PESTS. R. M. McPherson, Va. Polytechnic Inst. and State Univ., East. Va. Res. Stn., Warsaw, Va. 22572, and J. C. Smith, V. P. I. & S. U., Tidewater Res. and Cont. Ed. Ctr., Suffolk, Va. 23437.

Early-planted soybean fields were evaluated in 1980 for attracting overwintered Mexican bean beetles, bean leaf beetles, stink bugs, and Arthropod predators. 'Trap Crops' plus nine additional later-planted soybean fields adjacent to the traps were sampled with a 38-cm sweep net weekly in Westmoreland and Richmond counties.

Mexican bean beetles were very heavy in both trap crops in early season. Populations in adjacent full-season and double-cropped fields were low throughout the year. Bean leaf beetle adults were present in high numbers only in the Westmoreland trap crop. First and 2nd generation adults were collected in late-June and late-July. Stink bug population densities approached economic threshold levels in the Westmoreland trap on 8 Aug. No other fields had significant populations of this pest.

Spider population densities were not significantly different in any of the fields sampled. Big-eyed bugs and nabids were significantly more abundant in the trap crops and other full season fields than in the double-cropped soybeans. Lady bugs were most numerous in the double-cropped fields.

SUBLETHAL EFFECTS OF CARBARYL ON REDUVICLUS
AMERICOFERUS (CARAYON) (HEMIPTERA:NABIDAE).
P. R. Mehring* and R. L. Pienkowski. Dept. of
Entomology, Virginia Polytechnic Institute and
State University, Blacksburg, Va. 24061
     The goal of this research was to quantify long
term effects on an insect predator after exposure
to carbaryl. We collected damsel bugs from
alfalfa and exposed them to carbaryl-treated
surfaces for 12 hours. We used probit analysis
to estimate insecticide concentrations which
should produce 2% (LC_2) and 20% (LC_{20}) acute
mortality. We exposed 100 field-collected nabids
to LC_0 (control), LC_2 and LC_{20}, and maintained
them on alfalfa bouquets with food. We used both
males and females. About 40% of the nabids
contained parasites. We recorded the number of
days each individual lived following the exposure.
     The result was a decreased longevity for nabids
in the LC_{20} treatment. The mean posttreatment
longevity for the control and LC_{20} groups was
27.7 days and 19.2 days. Gender and parasitism
did not significantly affect this result.

EFFECT OF ROW SPACING ON INSECT POPULATIONS, USING TWELVE
COMMERCIAL VARIETIES OF SOYBEAN. D. A. Morris* and J. C.
Smith. Dept. of Entomology, Va. Polytechnic Inst. and State
Univ., Blacksburg, VA 24061
     Twelve commercial varieties of soybean were used to test
spacing effects on insect population levels. On June 18,
1980, each variety was planted in 24 inch and 12 inch row
spacings at a population density of 150,000 plants per acre.
Weekly sweep net samples demonstrated that early season
insects, spotted cucumber beetle, Diabrotica undecimpunctata
howardi (B.) and bean leaf beetle, Ceratoma trifurcata (F.),
had varietal preferences and that population numbers were
significantly higher in 24 inch spaced rows. Late season
insects, green cloverworm, Plathypena scabra (F.) and corn
earworm, Heliothis zea (B.), showed varietal preference, but
row spacing had no significant effect on population numbers.
Nabids, Nabis spp., showed no varietal preference, nor were
they affected by row spacing. Big-eyed bugs, Geocoris spp.,
had both varietal preference and higher numbers in 24 inch
spacings. Overall, when a spacing effect was observed, the
24 inch spaced rows had significantly higher insect popula-
tions.

COMPARISON OF SUPPLEMENTS TO POOR QUALITY HAY FED TO GROW-
ING CATTLE. Isabelle Ortigues*, J. P. Fontenot, Michele
Cochran* and W. H. McClure*. Va. Polytechnic Inst. and
State Univ., Blacksburg, Va. 24061.
     Sixty heifers and steers, weighing 185 kg to 360 kg ini-
tially, implanted with Ralgro and wintered outdoors, were
allotted to five treatment groups. Each group received fes-
cue hay ad libitum in addition to one of the following five
supplements: 1) none (N), 2) deep stacked broiler litter
mixed with a minimum of corn, ad libitum (L); 3) urea in
liquid supplement ad libitum (U); 4) urea-liquid supplement
injected in the bales (INJ) and 5) soybean meal (SBM). The
daily gains of SBM, L and U groups were higher than those of
the INJ and N groups (P<.05). Values were .31, .27, .26,
.14 and .12 for cattle fed SBM, L, U, INJ and N, respectively.
The ratios of daily hay consumption, dry basis, to daily
gain were: 105 (N), 57 (INJ), 46 (U), 48 (L) and 27 (SBM).
The ratios of daily crude protein consumed to the daily gain
were: 10 (N), 8 (INJ), 6 (U), 6 (L) and 3 (SBM). The blood
samples taken after an overnight fast initially and after 71
and 119 days did not show any differences in blood urea and
plasma inorganic phosphorus, calcium and magnesium. Analy-
sis of repeated samplings of injected bales showed poor dis-
tribution of the liquid in the bales.

NUTRIENT COMPOSITION AND TRUE METABOLIZABLE ENERGY VALUES OF
SOME TROPICAL FEEDSTUFFS. V. Ravindran*, E. T. Kornegay, L.
M. Potter*, K. E. Webb, Jr. and C. M. Parsons*. Dept. of
Animal Science and Dept. of Poultry Science, VPI & SU,
Blacksburg, Va. 24061
     Three Sri Lankan feedstuffs were analyzed for their proxi-
mate composition, cell wall composition, mineral components
and amino acid composition. The crude protein contents (dry
basis) of cassava tuber meal (CTM), cassava leaf meal (CLM)
and sesame oil meal (SOM) were 2.9, 20.2 and 35.2%, respec-
tively. CTM contained 88.4% nitrogen-free extractives, but
was poor in minerals and amino acids. SOM had a silica con-
tent of 12.2%, indicating adulteration with sand. SOM was
rich in all minerals, especially Ca (2.32%), Mg (.56%), P
(1.04%) and Fe (.32%). CLM contained high amounts of Zn (249
ppm) and Mn (252 ppm). True metabolizable energy (TME) of
these feedstuffs for poultry were determined using 24 adult
single comb White Leghorn roosters. After a 24-hour fasting,
six roosters were force-fed 25 g of each of these feedstuffs.
Six roosters, fasted for another 48-hour period, served as
the negative controls. Excreta was collected for two consec-
utive 24-hour periods. A 24-hour collection period was found
to be adequate for CTM and SOM, whereas a 48-hour collection
period was required for roosters force-fed CLM. The mean TME
values (dry basis) of CTM, CLM and SOM were determined to be
3.76, 1.82 and 2.42 kcal/g, respectively.

THE INFLUENCE OF DENSITY ON YIELD OF LOBLOLLY PINE PLANTA-
TIONS. D. D. Reed* and H. E. Burkhart, Biometrics Section,
Department of Forestry, Virginia Polytechnic Institute and
State University, Blacksburg, Virginia 24061.
     Many, if not all, published stand-level yield models in-
dicate that maximum yield is achieved at increasingly dense
stands as age increases. Density here refers to the number
of stems per unit area. After examining the results from a
number of spacing studies, we found that this trend is not
supported by the data. The field studies seem to indicate
an opposite trend; i.e., the number of stems per unit area
necessary to maximize yield decreases as age increases.
     One possible explanation of the differing trends between
the yield models and the spacing studies may be in the met-
hod of selecting sample plots used to develop the yield mod-
els. Sample plots are often located in well stocked portions
of plantations which may not be representative of the entire
stand and may mask the effect of density on yield.
     The density trends displayed in the spacing studies can
be incorporated into yield models by selecting appropriate
variables for inclusion. Using data from loblolly pine plan-
tations, yield models were fitted with age and density terms
specified to insure that yield-density relationships would
conform to those found in spacing studies. These empirical
fittings showed very little change in the goodness of fit
(as compared to models used in the past) while exhibiting
more reasonable behavior from a biological standpoint.

CONTROL OF EUROPEAN CORN BORER WITH VARIOUS INSECTICIDES.
J. E. Roberts, Sr., and Joseph L. Despins*, Dept. of
Entomology, Va. Polytechnic Inst. & State Univ., Blacksburg,
Va. 24061.
     Tests were conducted in 1980 for the control of European
corn borer by means of insecticides applied to the soil and
to the foliage of corn. Ample populations of European corn
borer were available, however, the results of these tests
left much to be desired. Results of these tests will be
presented.

ARE CORN ROOTWORMS AN ECONOMIC PEST OF FIELD CORN IN VIRGINIA? J. E. Roberts, Sr., and Joseph L. Despins*, Dept. of Entomology, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061.

Corn rootworm tests have been conducted in Virginia for several years. Results of these tests would indicate that corn rootworms are not really a problem in Virginia, even though, a considerable number of corn rootworm adults are present during the growing season. The results of tests conducted in 1979 and 1980 will be presented. These data indicate that the application of soil insecticides to corn indicate that the application of soil insecticides to corn in Virginia may not be a good investment if control of corn rootworms is the criteria used to measure the value of this investment.

APPARENT INSECTICIDAL RESISTANCE OF THE FACE FLY IN VIRGINIA ON BEEF CATTLE. J. E. Roberts, Sr., and Karl A. Magura*, Dept. of Entomology, Va. Polytechnic Institute and State University, Blacksburg, Va. 24061.

In previous years dust bag applications of insecticides have given 50-75% control of face flies on cattle. However, this has gradually decreased until we are now getting no control of face flies with dust bag applications of insecticides.

In 1979 Ectrin ear tags resulted in approximately 65% control of face flies on two herds of cattle on the VPI&SU Animal Science Farm. In 1980 Ectrin ear tags on these same cattle resulted in approximately 15% control of face flies. We believe this to be evidence of insecticidal tolerance or resistance.

Plans are under way to verify the validity of this thinking by means of laboratory testing.

CONTROL OF LONG NOSED CATTLE LICE WITH SUBCUTANEOUS INJECTIONS OF MK-933. J. E. Roberts, Sr., and Karl A. Magura*, Dept. of Entomology, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061.

Two separate tests were conducted in Montgomery County in the spring of 1980 for the control of long nosed cattle lice with subcutaneous injections of MK-933. These two separate tests resulted in very positive results in that the subcutaneous injections of this chemical gave absolute control of long nosed cattle lice for 42 days after the injections were applied.

AN OUTBREAK OF TWO SPECIES OF LECANIUM SCALE (HOMOPTERA: COCCIDAE) AND THEIR ASSOCIATED PREDATORS. P. B. Schultz and L. A. Parnell. Va. Truck & Ornamentals Research Station Virginia Beach, VA.

An outbreak of the oak lecanium scale, Lecanium corni complex, occurred in eastern Virginia in 1980 primarily on willow oaks. Examination of the scales on unsprayed trees just prior to hatch produced five predator species, four Hymenoptera and one Coleoptera. Adults of the genera Eunotus and Pachyneuron (Hymenoptera:Pteromalidae) were collected from 32% and 31% respectively from the 101 samples. In 14% of the samples, both genera were collected. Adults of the genus Coccophagus (Hymenoptera:Aphelinidae) were collected from 14% of the samples. Only 1 Blastothrix (Hymenoptera:Encyrtidae) and 3 Chilocorus (Coleoptera: Coccinellidae) adults were collected from the 101 samples.

The calico scale, Lecanium cerasorum, appeared suddenly and in very high numbers in 1980 on Zelcova trees in 3 eastern Virginia locations. The outbreak resulted in disruption of the sale of Zelcova trees from a commercial nursery. Adults of the genus Chilocorus were collected from the scale but no hymenopteran predators were observed with the calico scale.

Influence of early-season infestations of the tobacco fleabeetle, Epitrix hirtipennis (Melsheimer) (Coleoptera: Chrysomelidae) on the production of flue-cured tobacco. P. J. Semtner, Southern Piedmont Center, VPI & SU, Blackstone, VA 23824.

Field-collected tobacco flea beetles were confined at five different rates (0, 5, 10, 15 and 20 beetles/plant) to individually-caged plants of flue-cured tobacco for the 2-week period immediately after transplanting. The cages were then removed and insects feeding on the foliage were controlled during the remainder of the season. Plant height and leaf area measurements were taken at various times during the season and the green weight yield was determined.

Flea beetle densities of 0, 5, 10 and 15 beetles/plant did not have significant effects on the green weight yield, but the 10 and 15 beetles/plant rates had yield reductions of 8 and 12%, respectively. Tobacco infested with 20 beetles/plant had a 43% reduction in yield; reductions in leaf area of 42% for 6 weeks after transplanting, and 20 to 30% during the remainder of the season; plant height reductions of 33 to 37% for 6 weeks after transplanting, 24 to 27% for 7 to 8 weeks after transplanting and 17% at the end of the season. The leaf area of the tobacco infested with 10 and 15 beetles/plant was reduced 6 to 16% for 6 weeks after transplanting, and by 3 to 10% during the remainder of the season. Tobacco infested with 5 beetles/plant was not affected.

BREED OF SIRE EFFECT ON CARCASS CHARACTERISTICS OF OFFSPRING FROM ANGUS OR HEREFORD COWS. Margo Swortzel* and T. J. Marlowe, Dept. of Animal Science, VPI&SU, Blacksburg, Va

Four sire breeds, Angus (A), Hereford (H), Simmental (S) and Charolais (C) bred to A or H cows in 6 calf crop years produced 37 AA and 120 HH straightbred controls with 42 SxH and 84 CxH crossbred male calves for carcass evaluation. Stat model included birth year, sire breed, season of slaughter, sex, yr x sex, yr x sire, sire x sex, lin and quad reg of dam's age, lin reg on slaughter age and slaughter weight. Yr, sire, sex and slaughter age were significant for all variables except ribeye NS for yr.

	Sex		Live	Carc	Ribeye	Back	Marb	Percent
Brd	B	S	wt, lb	wt, lb	sq in	fat, in	score, pt	yield
AxA	25	12	968	541	11.78	.23	4.24	52.78
HxH	75	45	936	505	11.10	.17	3.57	52.98
SxH	23	19	1077	589	12.29	.13	3.31	53.38
CxH	51	33	1077	598	12.73	.16	3.28	53.49

Linear comparisons show large breeds sig (P < .01) advantage for live weight, carcass weight, ribeye and % yield with small breeds sig (P < .01) adv for back fat and marbling. Angus sig higher than Hereford (P < .01) for carcass weight, back fat and marbling. No significant differences between Simmental and Charolais.

POST-HARVEST CHEMICAL CONTROL OF PENICILLIUM BLUE MOLD OF APPLE. B. L. Tepper* and K. S. Yoder, Dept. of Plant Pathology and Physiology, VPI & SU, Blacksburg, VA 24061 and Winchester, VA 22601

Apples of six cultivars treated with a commercial fungicide schedule throughout the growing season were selected for uniform size and ripeness, randomized into 3 20-fruit replicates, punctured and inoculated with a 3 mm diam. dowel rod, dipped into a conidial suspension of benomyl-sensitive Penicillium expansum [1.3 X 10^5 conidia/ml]. At intervals of 4 or 24 hours after inoculation, the apples were dipped for 30 seconds in their respective fungicide treatments. Fruit was then stored for either one week at 18°C or 11 weeks at 0.5°C before decay incidence was rated.

Vangard (CGA 64251, 3.8 mg ai/L) resulted in 20% infection, but Vangard (7.5 mg ai/L) permitted only 2% rot. The standard fungicide applications of benomyl (Benlate, 300 mg ai/L), and a captan + benomyl mixture (600 mg + 300 mg ai/L) resulted in levels of control equal to that of Vangard (7.5 mg ai/L). Bitertanol (Baycor, 900 mg ai/L) allowed 62% decay. Fungicide treatments 4 hours after inoculation gave better rot control than treatments applied 24 hr after inoculation. Vangard, benomyl, and captan + benomyl all gave effective rot control for the 11-wk storage period.

LD50's (mg ai/L) for germination of P. expansum conidia on glass slides were, respectively: captan + benomyl, 0.07 + 0.07; benomyl, 0.10; Vangard, 0.25; captan, 1.04; and bitertanol, 3.98.

POST-HARVEST CHEMICAL CONTROL OF BROWN ROT AND RHIZOPUS ROT OF PEACH AND NECTARINE. B. L. Tepper* and K. S. Yoder, Dept. of Plant Pathology and Physiology, VPI & SU, Blacksburg, VA 24061 and Winchester, VA 22601

Fruit treated with a captan-benomyl program were harvested 5-7 days after the last spray, selected for uniform size and ripeness, punctured to a depth of 3.2 mm with a 3.2 mm diam. nail, and placed into plastic containers (20 fruit/container). Fruit were inoculated by dipping in conidial suspensions of Monilinia fructicola or Rhizopus sp. for 30 seconds. Three hours after inoculation, the fruit were dipped for 30 seconds in fungicide suspensions and allowed to dry. The fruit containers were placed into polyethylene bags for 5 days storage at 16-22°C before evaluating decay incidence.

Brown rot incidence was greater on nectarines than on peaches. Dicloran (Botran, 900 mg ai/L) did not adequately control brown rot on either fruit. Benomyl (Benlate, 300 mg ai/L), Vangard (CCA 64251, 15 mg ai/L), and iprodione (Rovral 600 mg ai/L) provided good brown rot control on peaches. On nectarines benomyl (300 mg ai/L), Vangard (15 mg ai/L) and iprodione (1.2 g ai/L) gave significant control of brown rot when compared to the untreated and inoculated control.

Rhizopus rot was reduced by dicloran (900 mg ai/L), dicloran + benomyl mixture (900 mg + 300 mg ai/L), and iprodione (1.2 g ai/L), but none gave commercial control. Vangard and benomyl did not adequately prevent Rhizopus rot. No phytotoxic effects by the chemical treatments were observed.

EVALUATION OF RACING PERFORMANCE IN STANDARDBRED HORSES. E. A. Tolley, D. R. Notter and T. J. Marlowe, Dept. of Animal Science, VPI&SU, Blacksburg, Va 24061

Official racing records from the U.S. Trotting Assoc. for 2- and 3-yr-old trotters at Blue Bonnets, Montreal, Canada, were analyzed to determine the effects of the following variables on horse's time at finish for mile races.

LEAST-SQUARES ESTIMATES AND STANDARD ERRORS
FOR RACING TIME IN SECONDS

Effect	2-year-olds	3-year-olds
Overall mean	132.01 ± .34	129.30 ± .33
Sex		
Stallions	131.81 ± .75	129.53 ± .58
Mares	132.22 ± .85	129.25 ± .64
Geldings	-	129.13 ± .73
Post position		
1	132.04 ± .50	128.96 ± .37
2	132.42 ± .52	129.50 ± .37
3	132.14 ± .54	129.43 ± .36
4	131.84 ± .57	129.36 ± .36
5	132.02 ± .52	129.06 ± .36
6	131.55 ± .52	129.30 ± .38
7[a]	132.08 ± .49	129.59 ± .37
8[b]	-	129.22 ± .36
Breaking code		
Not breaking stride	130.81 ± .39	128.02 ± .32
Breaking stride	133.20 ± .47	130.58 ± .37

[a] Includes post positions 7 and above for 2-year-olds.
[b] Includes post positions 8 and above for 3-year-olds.

ENSILING CHARACTERISTICS OF STOCKPILED TALL FESCUE. R.A. Torres*, J.P. Fontenot, K. E. Webb, Jr.*, F. S. McClaugherty* R.E. Blaser and V. Allen*. Dept. of Animal Science, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061.

A study was conducted to determine the effect of time of harvesting, wilting and addition of ground corn grain (5%) dry molasses (5%) and formic acid (.3%) on the fermentation characteristics of stockpiled Kentucky-31 tall fescue. The fescue was stockpiled beginning in August and was harvested and ensiled in October and November. At the October harvest forage was ensiled directly and after wilting, and in November the forage was ensiled without wilting. Water soluble carbohydrate content of the October forage was 18.7% for the forage ensiled directly and 17.3%, dry basis, for the wilted forage. The value was 18.1% for the November forage. All silages had desirable appearance and aroma. Average pH values were 5.1 and 5.6 for October silages ensiled directly and after wilting, respectively, and 5.2 for the ensiled November forage (P<.05). Lactic acid content followed similar trends, with respective values of 3.8, 2.1 and 3.0%, dry basis. Average pH values for fescue ensiled alone and with added formic acid, corn and molasses were 5.4, 5.5, 5.1 and 5.2, respectively (P<.05). Respective values for lactic acid content were 3.0, 1.6, 4.1 and 3.3%, dry basis (P<.05). No advantage of wilting was observed.

A METHOD OF OPTIMIZING SIMULATED PRODUCTION IN LOBLOLLY PINE PLANTATIONS. Steven A. Walker* and Harold E. Burkhart, Biometrics Section, Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

Methods for determining optimal management strategies were developed using a loblolly pine stand simulation model. A constrained flexible polyhedron search was used to maximize the simulated volume and dry weight. When this method failed, a second optimization technique, response surface analysis, was used.

The stand simulator for loblolly pine plantations (PTAEDAS) was used to generate yield responses for various site indexes, initial density, and thinning conditions. The results show that at the lower site indexes (50 and 60), the flexible polyhedron search was sufficient to find an optimum for both dry weight and volume, while at site index 70 the response surface technique was required.

ZINC, MANGANESE AND IRON CONCENTRATIONS IN APPLE LEAF SAMPLES TREATED WITH ZINEB, MANCOZEB, AND FERBAM FUNICIDES. K. S. Yoder and S. J. Donohue, Dept. of Plant Pathology and Physiology, VPI & SU Fruit Research Laboratory, Winchester, VA 22601 and Dept. of Agronomy, VPI & SU, Blacksburg, VA 24061

The fungicides benomyl (Benlate 50W), ferbam (Carbamate 76W), mancozeb (Dikar 76.7W, 72% mancozeb) and zineb (Zineb 75W) were applied at recommended rates with a high pressure single-nozzle handgun to mature 'Delicious' apple trees in a randomized block design with three single-tree plots. Leaf samples were collected from the mid-portions of terminal shoots 0, 4, 7, 14 and 21 days after the final application of the season. Element analysis was determined by atomic absorption spectrophotometry according to standardized procedures by the VPI & SU Soil and Plant Analysis Lab.

The ferbam treatment caused a 2-3X increase in Fe concentration over that of non-ferbam treated leaves. The mancozeb treatment gave a 4-5X increase in Mn. Zn content of zineb-treated leaves was 10-20X that of leaves from other treatments. Differences between concentrations of Fe, Mn and Zn in treated and non-treated samples were still evident 21 days after treatment although significant declines in Fe and Mn on treated foliage occurred over this period. Differences in Fe, Mn and Zn content of treated and non-treated leaves were also apparent following a tap-water rinse of a duplicate leaf sample.

BLISTER SPOT OF 'MUTSU' APPLES IN VIRGINIA. K. S. Yoder, G. H. Lacy and B. L. Tepper*, Dept. of Plant Pathology and Physiology, VPI & SU Fruit Research Laboratory, Winchester, VA 22601 and Blacksburg, VA 24061.

Symptoms resembling those of blister spot, a bacterial disease capable of reducing the fruit quality of 'Mutsu' apple were first observed in Virginia in Rappahannock County in 1980. An average of 31% of the fruit showed symptoms in the affected orchard with 8% downgrading in quality according to USDA grade standards. A bacterium was isolated repetitively from fruit lesions. By their reaction in standard bacteria identification tests (agar fluorescence, gel liquification, hypersensitivity on Burley 21 tobacco, arginine dihydrolase, oxidase, and lactate utilization), these isolates resemble isolates of Pseudomonas syringae pv. papulans, the blister spot pathogen, from New York and Ontario. Confirmation of the identity of the Virginia isolates awaits proof of pathogenicity through inoculation studies on apple.

A COMPARISON OF SAMPLE DATA TYPES IN QUANTIFYING DIAMETER DISTRIBUTIONS WITH THE WEIBULL FUNCTION. B. R. Zutter*, and R. G. Oderwald*. Biometrics Section, Dept. of Forestry, VPI & SU, Blacksburg, VA 24061.

A simulation study was undertaken to determine whether censored and/or truncated sample data might be used in lieu of complete data in quantifying diameter distributions with the Weibull function. Three levels of intensity of censoring and truncation were examined to determine whether intensity had an effect on distribution quantification.

Monte Carlo simulation was used to generate samples from a 2 parameter complete Weibull distribution. Twenty-five parameter combinations were used in data generation, covering the range of combinations encountered when fitting data from even and uneven-aged stands. For each sample the parameters of a 2 parameter complete Weibull were found using the method of maximum-likelihood. Comparisons among the sample data types were made based upon statistics computed for each fit distribution.

Based upon the comparison criteria, truncated data were judged to be unsuitable for quantification of complete diameter distributions. Distribution quantification using censored data at the two lowest levels of censoring was nearly as good as using complete data. It was concluded that the collection of censored data may be an alternative to complete data depending upon the results of field studies and the desired level of precision set by the forest manager.

Astronomy, Mathematics, and Physics

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University

A FREQUENCY-MODULATED COIL SENSOR FOR MAGNETIC SUSPENSIONS. Bruce E. Bernard*, W. Stephen Cheung*, and Rogers C. Ritter*. Dept. of Physics, University of Virginia, Charlottesville, Va. 22901.

A frequency modulated (FM) coil sensor using digital electronics is described here for use as a position transducer in a magnetic suspension. This is similar to the Q-coil method of Beams used in magnetic suspensions except that a different parameter, the oscillation frequency, is being controlled. The change in resonant frequency of an LC tank circuit as the suspended object moves is the basic signal. The frequency of the LC tank circuit is mixed with a stable frequency standard and the output of the mixer is converted into a voltage by a frequency to voltage converter. This voltage constitutes the control signal and with appropriate gain and electronic damping is used to suspend the object. Two advantages of this FM suspension circuit are that the control signal is independent of the amplitude of the LC tank circuit and is less sensitive to changes in temperature than the Q-coil method of suspension. Supported by NSF Grant PHY80-07948 and NBS Grant G8-9025.

CURRENT STATUS OF THE INERTIAL CLOCK EXPERIMENT. W. Stephen Cheung* and Rogers C. Ritter*, Department of Physics, University of Virginia, Charlottesville, Virginia 22901.

An ultra high Q inertial clock was proposed to test non-metricity of gravity[1]. It involves two corotating rotors, doubly magnetically suspended along their rotating axis, with the upper rotor providing protection to and also made to follow the lower rotor which is the inertial time keeper. Parametric optical transducers employing synchronous detection and the phase locked loop method for suspensions with enhanced stability and noise immunity were reported. Recent development involves a hybrid double suspension with optical and frequency-modulation coil[2] sensors for the upper and the lower suspension respectively. Our apparatus for the Snyder algorithm[3] to measure the rotors' rotational periods is also near completion. This algorithm permits significantly less experiment time for acquiring the desired precisions.

Apparatus for the clock experiment will be illustrated. This research is supported by NSF Grant PHY80-07948 and NBS Grant G8-9025.

1. W. S. Cheung and R. C. Ritter, Virginia Academy of Science meeting, 1980.
2. B. E. Bernard, et al., Virginia Academy of Science meeting, 1981.
3. J. Snyder, NBS, private communication.

INFRARED SPECTRA OF ASYMMETRIC TOPS. G.E. Copeland and P.M. Fazio, Dept. of Physics, Old Domionion University, Norfolk, VA 23508

The method of calculation of line positions and strengths for asymmetric rotors is described. Rigid rotor matrix elements are calculated in the symmetric rotor representation $|JKM>$ and then diagonalized to yield the rotational energy levels (E_{τ}). Eigenvectors so obtained $|J\tau M>$ are used to calculate dipole derivative matrix elements. Selection rules for a, b and c type transitions, together with population factors, are implemented to calculate the vib-rotational infrared spectra for any molecule. Improvements to introduce non-rigid behavior are described.

SUPERCONDUCTING ELECTRONICS. Bascom S. Deaver, Jr. Dept. of Physics, University of Virginia, Charlottesville, VA 22901.

Superconducting devices have emerged from the research laboratory and are now being used in electronic systems providing heretofore unattainable levels of precision, speed, sensitivity and low loss. Devices based on the Josephson effects and fluxoid quantization make possible amplifiers and detectors that approach quantum noise limits and digital devices with picosecond switching times. Together with integrated circuit technology these devices are being used for instruments and digital systems that extend by several orders of magnitude the sensitivity available for magnetic measurements and make possible computers 10-100 times faster than the best present ones.

DYNAMIC VISIOPLASTICITY - A NEW APPROACH IN PLASTICITY. S. N. Dwivedi, Dept. of Physics, Old Dominion Univ, Norfolk, VA

The visioplasticity was introduced by Thomsen and later developed by the author. In this method, the grid line patterns are photographed for each incremental step of deformation and thus the movement of grid points can be determined. From enlarged photographs of consecutive grid patterns the instantaneous velocities of all grid node across the surfaces can be found. The strains, strain rates, total effective strain can thus be determined for all points in the deformation region and finally the stress field and forming loads may be found.

In this method the instantaneous flow field is an actual one and gives information of all strains and stresses over the entire deformation region. It may be used for both workhardening and non-workhardening materials.

CONTINUING EDUCATION: NEEDS OF PHYSICISTS AND NEEDS IN PHYSICS. R. Ehrlich*, W. M. Black*, Physics Department, George Mason Univ., Fairfax, VA 22030

We have conducted two recent surveys of physicists and engineers in the Greater Washington D.C. area to assess their continuing education needs. Respondents to the physics survey appear to have a number of similarities to the respondents in a recent AIP national survey, and hence their views on continuing education and their needs for specific topics may well be of general interest. Despite the fact that 74% of the physicists surveyed already hold the Ph.D. they continue to have strong needs for continuing education, with the need more in engineering than physics.

The survey of engineers is also of interest since our concern here encompasses both the continuing education needs of physicists as well as the continuing education needs of anyone who may be interested in physics. The surveys include several novel elements in terms of methodology, and should be of interest to anyone attempting to assess regional continuing education needs in any discipline.

SUPERCONDUCTIVITY OF SMALL Pb PARTICLES PRODUCED BY CHEMICAL TECHNIQUES. T.L. Fariss*, W.E. Nixon*, B.S. Deaver, Jr. and J.W. Mitchell. Dept. of Physics, Univ. of Virginia, Charlottesville, VA 22901.

Chemical techniques are being developed for producing small superconducting particles and microstructures in an insulating medium. The techniques give good control of particle size and shape and a very small spread in particle size can be obtained so that size can be a controlled variable in studying particle properties. Particles with mean dimensions from 1 μm to less than 10 nm are being produced. The particles are characterized by optical and electron microscopy and electron diffraction, and the superconductivity is being studied by measurements of the magnetization as a function of temperature and magnetic field.

SURFACE CRITICAL PHENOMENA. Carl P. Franck*and Stephen E. Schnatterly* Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901

We are studying the critical demixing transition of carbon disulfide and nitromethane in the vicinity of a glass wall which preferentially adsorbs nitromethane. By measuring the reflectivity of the fluid/glass interface as a function of temperature, we are testing theories of surface critical phenomena. For example, it has been suggested by de Gennes and Fisher[1] that a wall layer with a thickness on the order at a correlation length should appear in such a system.

[1] C.R. Acad. Sc. Paris, t.287 (1978), Série B - 207.

THEORY OF GROUP PERIPHERIES. Richard I. Gomberg, NASA Langley Research Center, Hampton, VA 23665.

Let G be a group and H a subgroup of G. Then $P_G(H) \equiv \{G-H\}$. The properties of $P_G(H)$, called the periphery of H in G, are based on two fundamental lemmas.
 (i) If $h \in H$, and $p \in P_G(H)$, then $hp \in P_G(H)$.
 (ii) h can always be expressed as the product of two elements $P_G(H)$.
Applications are made to Abelian Groups, Sylow Groups, Solvable Groups, Isomorphisms, and Permutations.

SCATTERING OF LIGHT FROM ROUGH SURFACES. M. Haller*, V. Celli and A. Marvin*. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901

The scattering at electromagnetic waves provides a useful tool in studying rough metal surfaces. The surface roughness couples the incident radiation to the surface plasmon oscillations (SPO) causing excitation of these modes. These surface plasmon oscillations may then diffract through the surface roughness into other SPO modes or they may decay back into the continuum. The depolarization of the incident light and the intensity maxima at certain scattering angles may be attributed to these processes.

MÖSSBAUER STUDIES OF IRON SPIN DYNAMICS. G.R. Hoy, Dept. of
Physics, Old Dominion University, Norfolk, VA 23508.
    Mössbauer spectra of substances which magnetically order
often show a central peak with prominent wings in the region
of the ordering temperature. While commonly attributed to
the co-existence of paramagnetic and ordered components, we
will show that these "anomolous" spectra can arise from atom
spin fluctuations on a time scale of ~10^{-9} sec. Recently
developed theoretical techniques allow the effects of such
dynamic processes on Mössbauer spectra to be calculated.
The resulting analysis can yield information about: the
atomic Hamiltonian, the nature of the hyperfine interaction,
the magnetic ordering, the origin of the dynamic process,
and the spin fluctuation rate. We will present model calcu-
lations for Kramers' (S = 1/2) and non-Kramers' (S = 1)
salts. The characteristic differences between the two cases
will be emphasized, and the dependence of these spectra on:
the spin Hamiltonian parameters (D, E), the reduced magneti-
zation, and the spin fluctuation rate will be examined. In
particular, we will investigate the region near the ordering
temperature to show the effects on the spectra of short
range order and critical slowing down of the spin fluctua-
tion rate.

ENERGY LOSS OF SWIFT DIATOMIC NITROGEN IONS IN CARBON
FOILS.** E. A. Johnson,*[1] D. S. Gemmell,* E. P. Kanter,*
M. F. Steuer,*[2] and B. J. Zabransky.* Physics Division,
Argonne National Laboratory, Argonne, Ill. 60439.
    Soon after a fast (MeV) diatomic ion penetrates the
surface of a foil, collisions with target electrons strip
away the ion's binding electrons, leaving two charged
fragments. The correlated motion of these fragments, due
to their mutual electrostatic repulsion, influences the
measured energy loss of the fragments.
    This note describes recent energy loss experiments by
Argonne's molecular ion beam group and presents several
calculations involved in the analysis of experimental
results.

DECAY TIME STUDIES OF MAGNETICALLY SUSPENDED ROTORS.
G. R. Jones, Jr.*, and R. C. Ritter*. Physics Department,
University of Virginia, Charlottesville, Virginia 22901.
    Decay time studies have been performed on four rotors
with masses of approximately 250 gm and support slugs
of different shapes and materials at frequencies from
0 to 8 Hz. For supporting the rotors a split-photodiode,
optically sensed magnetic suspension was used. All of the
rotors exhibited decay time values at least an order of
magnitude below the values predicted by the gas friction
rule, thus suggesting that anomalous drag mechanisms are
in effect. Further, the spectra of decay time versus
rotational frequency exhibited properties which suggest
some type of mode coupling and/or interaction between
the rotor and the support. Additional studies further
implicated the support as a probable source of anomalous
torques. This research is supported by NSF Grant
PHY80-07948 and NBS Grant G8-9025.

THE UNSTABLE MIXED LAYER AS A SOURCE OF DOWNWARD PROPAGATING
NEAR-INERTIAL MOTION. John Kroll, Dept. of Math. Sciences,
Old Dominion University, Norfolk, VA 23508
    The stability of a one layer turbulent slab model of the
mixed layer over a continuously stratified, inviscid, semi-
infinite ocean is investigated for large scale ($\geq 0(1$ km))
perturbations. We assume the steady state values for the
velocity, density and depth of the mixed layer are essen-
tially uniform in time and space and use eddy viscosity.
The model is crude, but the results are interesting. A
critical point for instability is found at which the fre-
quency in most cases should be only slightly greater than the
local inertial frequency. This implies that the Ekman trans-
port could be a source of downward propagating inertial
motion and can be produced without wind curl. Also the down-
ward propagating inertial motion could be an important energy
sink for the mixed layer and limit its depth.

POWER MEASUREMENTS FOR NON-SINUSOIDAL A.C. WAVEFORMS. M.C.
Krutsch*, M.S. Eaton*, F.P. Clay, Jr. Dept. of Physics,
Old Dominion University, Norfolk, Va. 23508.
    Standard power meters used for the sale of electric
energy to customers are usually calibrated with sinusoidal
voltage excitation in a circuit yielding a sinusoidal
current response. A measurement of the energy used, from a
measurement of the true RMS voltage and the current response
shows a significant difference between the "metered" KWH's
and the energy actually supplied in a circuit containing
rectified currents. The existance of a difference between
the metered energy and the actual energy used may be a
significant economic consideration for electric power in-
stallations containing rectifiers, SCR's, etc.

KNIGHT SHIFTS IN AMORPHOUS VA1 AND VSi ALLOYS. L. Mattix
and H. E. Schone, Dept. of Physics, College of William &
Mary, Williamsburg, VA 23185.
    Amorphous alloys of VA1 (15 to 85 at .% A1) and VSi (5
to 25 at .% Si) have been prepared by r.f. sputtering onto
substrates held at 77°K. The V^{51} nuclear magnetic reso-
nance Knight shifts have been determined as a function of
A1 or Si concentration and of temperature.
    Our results in amorphous VA1 show no temperature depen-
dence. The V^{51} Knight shifts increase linearly with in-
creasing A1 concentration, and agree with the results of
crystalline alloy studies.
    In amorphous VSi, we see no temperature dependence in
the V^{51} shift even at the stoichiometric composition of the
A-15 compound V_3Si, which exhibits a very strong temperature
dependence in the V^{51} Knight shift. A temperature depen-
dence is seen in annealed VSi, probably due to the appear-
ance of V_3Si upon crystallization. This has been confirmed
by x-ray diffraction.
    We conclude that the major features of the density of
states curve near the Fermi level depend only on short range
order, and that this local order is the same for both the
amorphous and the crystalline alloys. The case of V_3Si is
an exception. The strong temperature dependence is due to
the presence of a sharp feature in the density of states
curve near the Fermi level which is peculiar to the A-15
structure. It is not surprising that this feature and the
resulting temperature dependence is not seen in the amorphous
phase.

THE NEW MAGNETIC MONOPOLES: SOME SPECULATIONS ON WHERE TO SEARCH. Stanislaw Mikocki and W. Peter Trower, Dept. of Physics, VA Tech, Blacksburg, VA 24061.
The failure to detect Dirac magnetic monopoles during the half century since their prediction is reviewed in the context of current grand unification theories. Specific experiments are proposed to search for monopoles with these augmented properties.

PARTICLE BEAMS AND PULSE STRETCHERS. Blaine Norum[*]. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901
Accelerators capable of delivering pulsed beams of charged particles for use in nuclear physics studies have been in operation for decades. However, many of the most promising experiments require continuous rather than pulsed beams. One method of generating such beams which utilizes the well understood technology of pulsed accelerators is to combine a standard pulsed accelerator with a "pulse stretcher ring". Each short pulse from the accelerator is stored in the ring and then extracted slowly during the interval before the next pulse arrives. Such a composite device has been proposed by the Southeastern Universities Research Association (SURA) for the generation of continuous beams of electrons with energies up to a few GeV.

RELATIVISTIC HEAVY-ION FRAGMENTATION BY ABRASION: DELTA FUNCTION INTERACTION. L. W. Townsend.* NASA Langley Research Center, Hampton, VA 23665
A zero-range (delta function) optical model potential approximation to the nucleus-nucleus multiple-scattering series is used in an abrasion-ablation collision formalism to predict cross sections for the fragmentation, by abrasion, of relativistic projectile nuclei in collisions with heavy target nuclei. General expressions for the abrasion cross sections will be developed and applied to specific projectile-target combinations for several different nuclear single-particle density distributions. For the Woods-Saxon distribution, comparisons between results obtained for zero-range and for finite-range interactions will be made. Comparisons with recent experimental results and with predictions from other theoretical models will also be presented.

THE PROTON HALO. W. Peter Trower, Dept. of Physics, VA Tech, Blacksburg, VA 24061.
In 1968 several fundamental experimental and theoretical results which were in conflict could be explained if the proton had a halo consisting of a few percent of its charge deployed at several fermis. We attempted an experiment to directly measure this halo which has recently succeeded. The nature of the motivating discrepancies and their eventual resolution are discussed as well as the current prospects for the halo in light of our data.

THE GEOMETRY OF SOAP BUBBLE CONFIGURATIONS. Peggy R. Wright, Lake Braddock Secondary School, Fairfax Co., VA.
This research was undertaken to describe and demonstrate the relationships between several factors governing the geometry of soap bubble configurations. Bubbles of different radii were formed and observed in groups and accurate measurements were taken of the angles of interaction. The previous work of Plateau was verified and extended by mathematical investigation of the data. This showed that internal pressure must be the primary force in the interactions between soap bubble surfaces.

Biology

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University

A COMPARISON OF THREE PHOTOMETERS FOR READING ENZYME-IMMUNOASSAYS PERFORMED IN MICROTITER PLATES. Steven B. Ackerman, Patti M. Mason, J. E. John and P. J. Adams, Dept. of Biology, Old Dominion Univ., Norfolk, Va. 23508

A popular novel serologic technique, enzyme immunoassay, is most often performed in clear plastic microtiter plates. The final step in this assay produces a color shift, which can be spectrophotometrically quantitated. The performance of a fiber optic probe colorimeter (Model 800, Brinkmann Instruments, Inc.) was compared to a spectrophotometer (Beckman Instruments, Inc.) and an ELISA-reader (Model MR 590, Dynatech Instruments, Inc.). We used as a chromophore source alkaline phosphatase/ p-nitrophenyl phosphate in 3N NaOH. Reproducibility values (100% - coefficient of variation) were 99.2% for the probe colorimeter, 99.1% for the spectrophotometer and 99.1% for the ELISA-reader, when one individual read the same sample at least 20 times in each instrument.Reproducibility for the colorimeter ranged between 96.4-97.2% when five individuals each performed 24 independent measurements. One way analyses of variances for mean absorbance values determined for 88 measurements indicated no significant differences between performances of the three instruments. However, the probe colorimeter did not demonstrate linear regression functions when absorbance values of a dilution series of chromophore was analyzed by least-square analysis. Advantages and disadvantages of each instrument for reading the enzyme immunoassay will be discussed.

AN ENZYME-LINKED IMMUNOASSAY FOR QUANTITATING ANTIBODIES TO HUMAN SPERM: COMPARISON WITH OTHER IMMUNOASSAYS. Steven B. Ackerman, J. W. E. Wortham and R. James Swanson. Andrology Laboratory, Dept. of Biology, Old Dominion University, Norfolk, Va. 23508.

An enzyme-linked immunosorbent assay (ELISA) was devised to measure antibodies to human sperm. Details of the procedural parameters and the reproducibility tests of this assay will be presented. Comparing ELISA with other commonly-performed antisperm assays, titers of rabbit antisperm sera, as measured by ELISA, Kibrick macroagglutination, Franklin and Dukes microagglutination, and Isojima immobilization, were 1/16,384, 1/32, 1/64 and 1/256, respectively. Results of our studies indicate that ELISA for detection of antisperm antibodies overcomes many of the problems associated with agglutination, immobilization, cytotoxicity and penetration assays: (a) no need to routinely obtain and maintain viable, motile sperm; (b) results are obtained objectively and rapidly, without the need for laborious microscopic evaluation by trained personnel; (c) by using enzyme-conjugates specific for individual immunoglobulin classes and/or sub-classes one can obtain in-depth knowledge as to the type of antibody responsible for antisperm activity; and (d) following determination of base-line values for clinically significant levels of antisperm antibodies, reagents may be diluted and procedures modified so that a qualitative assay is devised, which may be performed in the clinician office.

THREE FORMS OF ENZYME-IMMUNOASSAYS FOR DETECTION OF ANTI-SPERM ANTIBODIES. Steven B. Ackerman, Patti M. Mason, Stephen Keefe and Debra Martin. Dept. of Biology, Old Dominion University, Norfolk, Va. 23508.

Recently, we reported an enzyme-linked immunosorbent assay (ELISA) to detect antibodies to human sperm (Ackerman et al., 1981, Amer. J. Reprod. Immun., Vol. 1). In this current study several variations of this assay were examined. Sperm were employed in this assay as (a) intact cells absorbed to microtiter wells, (b) intact cells in suspension, or (c) soluble extracts (saline and detergent) or saline-insoluble cell components adsorbed to microtiter plates. Several methods of serum incubation and antigen washing procedures were also investigated for usefulness in this assay. Preliminary results suggest that maximal reaction intensities were obtained when freshly obtained sperm were used as intact cells in suspension. However, absorption of whole sperm or sperm fractions onto polystyrene microtiter plates were more convenient, since the need for fresh sperm each time the assay was performed was avoided.

ORGAN WEIGHTS OF RIVER OTTERS. Karen Lynn Anderson, and Patrick F. Scanlon. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

During the 1979-1980 trapping season, carcasses of 244 river otters, Lutra canadensis, from throughout the eastern portion of the state were obtained from trappers. Kidneys, adrenal glands, liver, heart, and spleen were removed from each otter and weighed to the nearest 0.01g. The mean weights (g ± S.E.) of each tissue was as follows: left kidney, 45.71 ± 0.77; right kidney, 47.01 ± 0.88; both kidneys, 92.54 ± 1.55; left adrenal, 0.50 ± 0.01; right adrenal, 0.45 ± 0.01; both adrenals, 0.95 ± 0.02; spleen, 60.36 ± 1.36; heart, 63.91 ± 1.60; and liver, 334.90 ± 6.23. Significant (P< 0.05) differences occurred between sexes in mean weight of left kidneys, right kidneys, paired kidneys, spleens and livers. Among females, no signigicant differences were found between mean weight of left and right adrenals or left and right kidneys. A significant difference was found between mean weight of left and right adrenals of males.

REPRODUCTION AND POPULATION CHARACTERISTICS OF RIVER OTTERS IN VIRGINIA. Karen Lynn Anderson and Patrick F. Scanlon. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

During the 1979-1980 trapping season, carcasses of 244 river otters , from throughout the eastern portion of Virginia were obtained from trappers. Of the 244 otters, 97 were female and 147 were male. Data on repro- duction was obtained by dissection and examination of the reproductive tracts. The mean number of corpora lutea in 24 ovulated females (all older than one year) was 2.5 0.089 (S.E.). The mean litter size for 8 females with pregnancies beyond the implantation stage was 2.75 ± 0.177. Pre- implantation mortality was estimated to be 8.34%. Ages of otters were estimated by counting annuli in the cementum layer of a lower canine tooth. The trapped otters were distributed in the age classes as follows: 0-1 yrs., 20.6%; 1-2 yrs., 33.2%; 2-3 yrs., 32.2%; 3-4 yrs., 9.3%; 4-5 yrs., 4.2%; and 5-6 yrs., 0.5%. Unadjusted age specific survival rate for the 0-1 year age class was estimated to be 1.61; for 1-2 yrs., 0.972; 2-3 yrs., 0.289; 3-4 yrs., 0.450; and for 4-5 yrs., 0.111. The recruitment rate (number of female pups per adult female was calculated to be 0.412 and the ratio of yearlings and juveniles to adult females was 2.618. The adjusted recruitment rate was 1.235. The otter population appears to be stable at the present time. However, repetition of this study for the 1980-1981 trapping season will provide more information on the status of the population.

HEAVY METAL CONCENTRATIONS OF TISSUES OF PINE VOLES FROM FOUR VIRGINIA ORCHARDS. Karen L. Anderson, Frederick A. Servello, and Patrick F. Scanlon. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Hair (washed and unwashed) and bone samples of pine voles, *Microtus pinetorum*, trapped during late fall and winter (1980-1981) in four Virginia orchards were analyzed to determine concentrations (g/g dry weight of tissue) of lead and cadmium. Concentrations of cadmium found were below the limit of detection (0.02 μg/g) in all tissues. Mean (± S.E.) lead concentrations found were as follows: (orchard A) bone, 10.73 (± 4.42); washed hair, 1.63 (± 0.95); unwashed hair, 1.33 (± 0.43); (orchard B) <0.2 for all tissues; (orchard C) bone, 1.30 (± 0.75); washed and unwashed hair, <0.2; (orchard D) bone, 28.17 (± 6.57); washed hair, 1.47 (± 1.47); unwashed hair, 2.19 (± 1.46). Lead concentrations did not appear to increase with age.

PERIPHYTON COMMUNITY STATUS IN THE RAPPAHANNOCK RIVER SYSTEM AND BULL RUN CREEK AFTER THE MARCH 1980 OIL SPILL. M. L. Bass, Dept. of Biological Sciences, Mary Washington Coll., Fred., Va. 22401 and W. G. Landis, Franklin Research Center, Silver Spring, Md. 20910.

On March 6, 1980 two simultaneous breaks occurred in Colonial Pipelines refined products line in Northern Vir- ginia. One break released 8,000 barrels of kerosene into a tributary of Bull Run Creek and the other released 2,190 barrels of No. 2 fuel oil into a tributary of Mine Run Creek. Sediment samples were tested for residual oil by gas chromatography. The results were correlated with the status of the periphyton community. Periphyton was sam- pled directly from natural substrate in late July and early August using a bar clamp sampler. An estimate of the num- ber of organisms/cm^2 at each sampling station was performed by microscopic identification and counting. Dry weight and ash-free weight analyses were performed by standard methods. Analysis of the periphyton community in the Rappahannock System 4 months post spill showed an increase in biomass at the nearest impacted station which is most likely due to increased bacteria and blue-greens with subsequent decrease in diversity and biomass followed by an increase or stabi- lization of these parameters at the farthest downstream stations. In Bull Run Creek 5 months post there was a de- crease in biomass and diversity at the nearest impacted station with a subsequent increasing trend of these param- eters downstream from the impacted area.

HEAVY METAL CONCENTRATIONS IN TISSUES OF RIVER OTTERS FROM VIRGINIA. Karen L. Anderson and Patrick F. Scanlon. Dept. Fisheries and Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Liver, kidney and bone samples were taken from 244 river otter, *Lutra canadensis*, carcasses collected during the 1979-1980 trapping season in Virginia. Concentrations of lead, cadmium, copper and zinc were determined using an atomic absorption spectrophotometer in the flame mode. The maximum concentration (g/g dry tissue) of each element found in the three tissues was as follows: (liver) Pb, 55.89; Cd, 0.99; Cu, 211.00 and Zn, 235.68; (kidney) Pb, 6.60; Cd, 14.09; Cu, 80.15 and Zn, 564.34; (bone) Pb, 35.16; Cd, 0.00; Cu, 5.69; and Zn, 822.93. The mean (±S.E.) concentrations in tissues were as follows: (liver) Pb, 1.40 (± 0.62); Cd, 0.09 (± 0.01); Zn, 62.23 (± 2.17); Cu, 13.92 (± 1.48); (kidney) Pb, 0.81 (± 0.07); Cd, 0.61 (± 0.09); Zn, 78.91 (± 4.88); Cu, 6.16 (± 0.59); (bone) Pb, 1.41 (± 0.22); Cd, 0.0; Zn, 179.13 (± 9.49); and Cu, 0.13 (± 0.04). Mean concentration of cadmium in kidney increased with age of otters indicating an accumulation of cadmium in otters as they became older.

MIGRATORY TIMING OF BROWN SHRIMP (PENAEUS AZTECUS) IN PAMLICO SOUND, NORTH CAROLINA. A. M. Babcock*, Dept. of Oceanography, Old Dominion University, Norfolk, VA 23508.

Migration of adult brown shrimp was analyzed using the time density approach. Time density refers to the prob- ability of the migration, and is estimated as the propor- tion of the total population (or the proportion of an observation which is proportional to the population, e.g. catch per unit effort). This model provides a dynamic model of shrimp migration throughout the entire fishing season. Catch statistics received during 1978-80 from Pamlico Sound, the Neuse River, the Pamlico River, and Core Sound were analyzed in this study. Indications of environmental characteristics of the areas observed were reflected in the time densities. Time densities proved to be stable and homogeneous which facilitated the use of this model for estimation of total catch throughout the fishing season.

FORAGING ECOLOGY OF ANOLIS LIVIDUS, AN ENDEMIC LIZARD ON MONTSERRAT, WEST INDIES. Garnett R. Brooks. Dept. of Biology Col. of William and Mary, Williamsburg, Va. 23185

Adult males of *Anolis lividus* obtain a snout-vent length (SVL) of 68-70mm, weigh 8-9g, and are usually 1.5 times longer and 3.5 times heavier than adult females. This species occurs in a variety of vegetational communities (scrub to rain forest) and occupies most available struct- ural habitats. All sizes are typical sit-and-wait predat- ors on small invertebrates. Data on structural habitat and stomach contents were obtained for 316 individuals taken over a four month period. Large males (SVL ≥ 56mm) occupied high perches, medium sized males and adult females (SVL = 41-55mm) occurred at intermediate heights, and small males and females (SVL ≤ 40mm) were found mainly on the substrate or on low perches. Ants were the major prey in terms of occurrence (96%) and in numbers (72%). Other important prey were roaches, spiders, lepidopteran larvae, adult coleopterans, and heteropterans. Individuals appeared to feed throughout their activity period. The mean number of prey per lizard was 19 and the mean prey length, 2.6mm. Only 7% of the prey were 6mm or longer. Mean prey length (but not mean number of prey consumed) was positively corre- lated with lizard size. However, mean prey length(and mean number of prey) for males and females of seven size group- ings were not significantly different. The later results are contrary to those found by Schoener (Science 155: 474- 477, 1967) for the solitary species, Anolis conspersus.

CULICOIDES SPECIES DISTRIBUTION IN THREE NEOTROPICAL LIFE ZONES (DIPTERA: CERATOPOGONIDAE). Dr. Joseph E. Browne, Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

Culicoides populations were sampled by light-trap collections on a regular basis for 2 years in three life zones in Colombia, South America. The species captured are grouped into abundant (+10%), common (+5 to 10%), occasional (+1 - 5%), and rare. The relative abundance of 18 species is compared from a tropical lower montane wet forest (1850 m), tropical premontane wet forest (1676 m), and a tropical dry forest (956 m).

EFFECT OF HOST DIET ON ESTABLISHMENT, GROWTH, AND MATURATION OF THE MOUSE BILE-DUCT TAPEWORM HYMENOLEPIS MICROSTOMA (Cestoda: Cyclophyllidea). Dr. Joseph E. Browne, Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508.

Separate groups of mice were maintained on a normal, or high protein, or high fat diet. Each mouse was infected with 8 cysticeroids of the bile duct tapeworm, Hymenolepis microstoma harvested from beetles of the genus Tribolium. At 15 days post-infection the number of worms harvested from the mice maintained on a high protein or high fat diet was significantly lower than the number from mice maintained on normal chow. The mean worm weight was significantly higher in the normal-chow mice in spite of the crowding effect due to a larger worm burden. Protein and glycogen assays of the worm tissue suggest that, unlike the cells of the vertebrate host, the worm has only limited capacity to convert fats or proteins into an energy substrate for metabolic activity.

RESPONSES OF SELECTED BLOOD CHARACTERISTICS TO NUTRITIONAL RESTRICTION IN WHITE-TAILED DEER. W.C. Card*, R.L. Kirkpatrick, K.E. Webb, and P.F. Scanlon. Dept. Fish and Wildlife Sciences and Animal Sciences, VPI&SU, Blacksburg, Va. 24061

This study was conducted to determine the effects of a long-term moderate nutritional restriction on selected blood characteristics in white-tailed deer (Odocoileus virginianus). Ten male adult deer were fed either ad libitum or 65 percent of the ad libitum energy intake on a metabolic body weight basis for 91 days beginning 24 October 1980. Follow-treatment, the restricted group was refed ad libitum for 14 days. Mean body weights for both groups combined declined 19 percent from an initial mean of 81 kg on the first day of the experiment. The restricted group maintained a 2 kg lower mean weight during treatment. This was not significantly different from the ad libitum group (P>.10). Mean serum concentrations of nonesterified fatty acids (NEFA's) differed significantly on day 7 of the experiment (P=.08) but not at later sampling periods (P>.10). Mean whole blood concentrations of β-hydroxybutyrate differed significantly on days 77 (P=.03) and 91 (P=.01) but not on earlier sampling dates (P>.10). No significant differences were found in concentrations of cholesterol, acetoacetate, or acetone (P>.10) during treatment. Following two weeks of ad libitum refeeding, mean concentrations of β-hydroxybutyrate for restricted animals increased 171 percent over those for the restricted period. (Supported in part by the John Lee Pratt Animal Nutrition Program).

RAT LENS GLUTATHIONE METABOLISM: IN VIVO AND IN VITRO RESPONSES OF GLUTATHIONE REDUCTASE TO SELENIUM. G. D. Clark and J. L. Hess, Dept. Biochemistry and Nutrition, VA Polytechnic Institute and State University, Blacksburg, VA 24061

In our study of cataractogenesis we have examined lens tissue in which cataract appears 72 h following injection of Na_2SeO_3 in 9-day old rats (20 μmoles/kg body wt). Significant decreases in glutathione levels in lens tissue occur after 24 h. We have determined that levels of NADPH-dependent glutathione reductase, essential for maintaining reduced glutathione, decreased from 55 units/g protein at day 9 to 35 units/g protein at day 21 in control animals. Selenite injected animals retained activity at 60 units/g protein at day 21.

These differences may reflect lens weight which increases less during this 12-day interval in the selenite-treated animals. During this period, total soluble protein was 30% less in the selenite-treated animal so that the actual specific activity of glutathione reductase appeared to increase. However, glutathione reductase activity/lens was 40% greater in selenite injected animals at 12 days post-injection (age 21 days). Enzyme levels appeared not to be altered during the period of cataractogenesis (initial 72 h post-injection). Between 1 mM to 0.01 μM selinite had no effect on enzyme activity in vitro. The K_m for glutathione was 63 μM. (Supported by NIH grant EY01060)

MACROBENTHOS AS THERMAL STRESS INDICATORS IN WESTERN LAKE ERIE AT LOCUST POINT, OHIO. Harold N. Cones, Jr., Dept. of Biology and Env. Sci.,Christopher Newport College, Newport News, Va. 23606.

Benthic macroinvertebrate collections for a three-year period from Locust Point, western basin Lake Erie, were analyzed to establish a data plane to be used in determining the effects of introduced thermal effluent from the new Davis-Besse nuclear power plant. The community proved to be an Oligochaete/Chironomid assemblage with other taxa represented by facultative or pollution-tolerant forms,indicating the presence of organic pollution at the study site. However, the study area is subject to storm-and wave-induced substrate shifting, suggesting the sampled forms may be more indicative of stress of shifting substrate than of stress of pollution. This was partially substantiated by statistical tests which showed extreme variance, with no statistical difference between stations, transects, or time. The high variance, a result of shifting substrate and of normal population dynamics, coupled with natural organic pollution at Locust Point, makes the determination of introduced thermal effluent on the population dynamics extremely difficult.

THE EFFECTS OF MELATONIN AND PHOTOPERIOD ON THE REPRODUCTIVE SYSTEM OF PINEALECTOMIZED MALE MICE, MUS MUSCULUS, ICR STRAIN. J.E. Constantine and F.B. Leftwich., Dept. of Biology, Univ. of Richmond, Richmond, Va. 23173.

Ninety-six male mice, age 4 wks., were obtained. Forty-eight mice were pinealectomized and 48 were sham operated. The animals were divided into 3 photoperiod regimens consisting of 1.5, 14, and 24 hr. light periods. On the 3rd to 60th post-operative days the mice were injected with 10 ug melatonin or control solution. On the 60th post-operative day, representatives of each photoperiod-surgery-injection regimen were mated with females; others were killed and several organs were removed and weighed. It was observed that organ weights of mice receiving similar injections under the same photoperiod were similar irrespective of surgery. Histological examination of testes showed normal spermatogenesis and presence of mature sperm. A reproductive study indicated that all mice were capable of producing offspring. Melatonin is shown to generally play a progonadal role but it appears that it is not mediated by the pineal in the male. Although pineal inhibition is implicated in female reproduction, the lack of effect in the male may serve to keep him in copulatory readiness at all times.

THE SEASONALITY OF OCCURRENCE OF LARVAL AND JUVENILE FISHES IN VIRGINIA'S SEASIDE ESTUARIES. James H. Cowan and Ray S. Birdsong, Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23508.

The seasonality of occurrence and relative abundance of larval and juvenile fishes from a Virginia seaside estuary was determined based on ichthyoplankton and trawl collections made from March 1979-March 1980.

The larvae of 20 species distributed among 15 families were identified from the ichthyoplankton. Larvae of the bay anchovy, Anchoa mitchilli, and the Atlantic silverside, Menidia menidia, dominated the samples and made up 57 and 34% respectively of all larvae collected. Peak occurrence began in May and continued through August. Fish larvae were present in the study area all year.

Twenty-eight species distributed among 19 families were identified from trawl collections and samples were dominated by juvenile sciaenids (6 species) which made up 68.0% of trawl collected individuals. Juvenile abundance peaked in September through December. Juvenile fishes were present in the study area all year.

Larvae and juveniles collected in this and other studies were divided in 5 ecological categories: I. Resident seaside spawners. II. Shelf spawners passively transported into the seaside estuaries. III. Post-larvae and juveniles actively seeking Virginia's seaside estuaries as nursery areas. IV. Sub-tropical intruders. V. Oligo- and Mesohaline species occasionally taken in seaside estuaries.

EFFECTS OF LITTER SWITCHING IN MICROTUS PINETORUM AND FOSTER REARING OF MICROTUS PENNSYLVANICUS AND PEROMYSCUS LEUCOPUS. Jack A. Cranford. Dept. of Biology, VPI & SU, Blacksburg, Va. 24060.

Maternal recognition of young is important to genetic survival, and rearing of unrelated young is maladaptive. To determine the importance of maternal recognition of offspring, litter exchanges (complete, partial, and litter increases) were carried out with Microtus pinetorum. Young were switched from newborn to 8 days of age and survival to weaning was determined. In complete and partial litter switches no infant mortality occured as a function of age or type of switch made. In experiments with increased litter size, litters were generally reduced to starting size. In 7 of 23 litters, litter size returned to normal; in 3, own and strange died; in 11, strange young were weaned, while 2 litters were totally destroyed. When Microtus pennsylvanicus or Peromyscus leucopus young were added, 23-37% were reared to weaning, while 73-80% of the original M. pinetorum were reared to weaning. Complete and partial switches suggest maternal females do not recognize their own young, and litter size increase experiments suggest that litter size constancy is more important than litter composition. In wind tunnel tests P. leucopus preferentially associated with M. pinetorum.

EFFECTS OF PRECOCENE II ON DERMACENTOR VARIABILIS (SAY) W. H. Dees, D. E. Sonenshine, and N. P. Buford*. Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508.

Precocene II, a juvenile hormone antagonist, was not found to affect sex pheromone activity or accelerate molting in the American dog tick, Dermacentor variabilis (Say). Topical application of precocene II was fatal to engorged nymphs. The presence of adult forms in the dead nymphs indicated a generalized toxic effect rather than specific alteration of developmental processes. Results were similar when engorged nymphs were exposed to precocene II by the contact method. Topical treatment of young adult females with precocene II failed to curtail sex attractant activity. (Aided by ONR grant N-00014-80-C0546)

SOME EFFECTS OF PICNICKERS ON A GRAY SQUIRREL POPULATION. J.F. Coyle*, Dept. Fish. Wildl. Sci., Va. Polytech. Inst. and St. Univ., Blacksburg, VA 24061

A population of gray squirrels (Sciurus carolinensis) was studied from 26 May to 23 December in Frank Newhall Look Memorial Park, Northampton, MA, to determine its relationship to human activity. The park was partitioned into 2 sampling strata: forested areas with picnic sites, and forested areas without picnic sites. Squirrel populations were monitored weekly using a time-area method on 6 plots in each stratum. No significant differences (P>0.05) in squirrel density indices between seasons or between strata were found. A significant positive association (P<0.001) between picnicker and squirrel levels was found. This may indicate that human disturbance influenced the spatial activity patterns and/or the observability of the squirrels. Feeding behavior modifications were also noted. Squirrels fed on foodstuffs left by picnickers during the summer months and returned to natural foods, such as mast, during the fall months. Leaf nests were significantly (P<0.05) higher in the forested areas with picnic sites, as were the trees in which the nests were constructed (P<0.01). Since large trees were located in both strata, the choice of larger trees, and therefore higher nests, could possibly be attributed to human disturbance.

OYSTER SHELLS AND ARTIFICIAL TUBES: THE ROLE OF REFUGES IN STRUCTURING BENTHIC INFAUNAL COMMUNITIES. D.M. Dauer, Dept. of Biol. Sci., Old Dominion Univ., Norfolk, Va. 23508; G.H. Tourtellotte, Envir. Sci. and Engin., Inc., 4506 Hoover Blvd, Tampa, Fla. 33614; and R. M. Ewing, Barry A. Vittor & Assoc., Inc., 8100 Cottage Hill Rd., Mobile, Ala. 36609.

Clumps of dead oyster shells and glass tubes were placed in the field in January 1980 in Broad Bay, Va., in order to study the role of spatial heterogeneities in reducing the mortality of benthic infauna by epibenthic predators. In May and August 1980 samples of the macro- and meiobenthos were collected. Oyster clump treatments consisted of bottom plots covered totally with oysters or plots with clumps uniformly spaced. Samples were collected beneath and between oyster clumps. Glass tubes secured to plastic plates simulated infaunal tube densities of approximately 2,000 and 3,500 tubes per square meter. Macrofaunal densities were significantly higher in all treatments except for the total oyster coverage in May. Meiofaunal densities were usually significantly higher in all treatments except the total oyster coverage at both collection dates.

Epifaunal community development on oyster shells and the glass tubes was also studied.

THE EFFECTS OF CAFFEINE ON A NEW SPERM RECOVERY SYSTEM. Ellen DeFlora* J.W. Edward Wortham, Jr., Andrology Laboratory, Dept. of Biological Sciences, Old Dominion University and J. Clark Bundren* Dept. of Obstetrics and Gynecology, Eastern Virginia Medical School, Norfolk, VA 23508.

Bundren, et al. recently introduced a new modified spermrise technique (DISRS) to isolate a fertile sperm fraction from oligospermic semen which would be suitable for AIH. Their study showed a strong correlation between the number of quick progressive sperm in the initial sample and the total number of sperm they were able to recover. The purpose of this study was to incorporate caffeine into the DISRS technique and study its effect on sperm motility.

Equal volumes of untreated semen, phosphate-buffer treated semen and phosphate-buffer-caffeine treated semen (100 ul each) were aliquotted into microcentrifuge tubes. These were incubated at $37^{\circ}C$ for one hour, then centrifuged at 270 xg for 5 minutes. Following centrifugation, the tubes were again incubated for 1, 2, or 3 hours. Supernatant motility was evaluated hourly according to the presence of quick progressive, sluggish progressive and non-motile sperm. These data were compared. It appears from these preliminary data that the application of caffeine may enhance the quality of the sperm fraction recovered by the DISRS technique.

COMPARISONS OF NATURAL POPULATIONS OF DROSOPHILA MELANOGAS-
TER FROM VIRGINIA FOR DRGREE OF SENSITIVITY TO AFLATOXIN B_1
S. Delawder* and J.P. Chinnici. Dept. of Biology,
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Natural populations of Drosophila melanogaster were col-
lected from areas in Virginia reporting aflatoxin contamin-
ation of corn and peanut crops and from areas reporting no
aflatoxin contamination. Eggs from each population sample
were placed on media containing 0.0, 0.5, and 1.0 ppm
aflatoxin B_1 (AFB_1). Data on egg-pupal and egg-adult de-
velopment times, egg-pupal and egg-adult viability frequen-
cies and the sex and body lengths of adults were collected
to determine the relative degrees of resistance to AFB_1.
Flies sensitive to AFB_1 show decreased viability, smaller
adult body sizes, and significant elongation of development
times. There appears to be a significant variation in re-
sistance to AFB_1 among the populations correlating with the
areas from which the flies were collected. Most of the re-
sistant flies come from aflatoxin contaminated areas and the
sensitive flies from aflatoxin free areas. Natural selec-
tion may be responsible for this correlation.

EFFECTS OF PHOTOPERIOD ON GROWTH & MATURATION OF M.
PINETORUM. Terry L. Derting and Jack A. Cranford. Dept.
of Biology, Virginia Polytechnic Inst. and State Univ.,
Blacksburg, VA. 24060

The effects of photoperiod on growth and maturation of
pine voles (Microtus pinetorum) was determined. Juveniles
raised under LD8:16 had significantly greater body weights
than those raised under LD16:8, beginning at 4-5 weeks of
age. Additionally, juvenile females 5 weeks of age
raised under LD8:16 had significantly greater uterine
weights than those raised under LD12:12 and LD16:8; while
females raised under LD12:12 had significantly greater
ovarian weights than those raised on LD16:8. There was no
significant effect of photoperiod on testes or seminal
vesicle weights of juvenile males at 5 weeks of age.
Adults showed the same response to photoperiod as juveniles,
with adults maintained on LD8:16 being heavier than those
maintained on LD12:12 or LD16:8. Adults switched from a
long photoperiod (LD16:8) to a short photoperiod (12:12 or
8:16) showed increased body weights when compared to
controls maintained on constant long photoperiod (LD16:8).
However, there was no effect of photoperiod on litter
size or frequency. In general, pine voles responded to
short photoperiods by exhibiting increased body weights
and juvenile females exhibited faster reproductive
development.

EFFECTS OF IONIC STRENGTH AND SPECIFIC IONS ACTIVITY ON
THE FUNCTION OF HEMOCYANINS FROM HORSESHOE CRABS. C. O. da
C.Diefenbach and C. P. Mangum. Dept. of Biology, Coll.
of William and Mary, Williamsburg, Va. 23185.

The respiratory properties of the hemocyanin, and oxy-
gen carrying protein, in the blood of the horseshoe crab
Limulus polyphemus are modified by the changes in inorganic
ions that occur when the animal enters an estuary. In this
study , the oxygen binding response to total salinity and
to the individual ions Na^+, Ca^{+2}, Cl^- and SO_4^{-2}
was investigated. In solutions containing only one salt,
at each of three concentrations ranging upwards to the
total ionic strength of native blood, oxygen affinity is
very high ($P_{50} < 7$ torr at pH 7.5 and 25° C). In solutions
containing virtually no inorganic ions , oxygen affinity is
only slightly higher ($P_{50} = 3.4$ torr at pH 7.5 and 25°C).
In solutions containing physiological concentrations of
$NaCl$ and $MgCl_2$, oxygen affinity is somewhat lower ($P_{50} =
8.2$ torr at pH 7.5 and 25°C), but still not as low as that
of the molecule in physiological saline ($P_{50} = 14$ torr at
pH 7.5 and 25°C). In solutions containing only physio-
logical concentrations of $NaCl$ and $CaCl_2$, however,
oxygen affinity is almost the same ($P_{50} = 13.5$ torr at pH
7.5 and 25°C) as that of the hemocyanin in physiological
saline. It is clear that the inorganic ions that are
responsible for the respiratory properties of the blood
are Na^+, Ca^{+2}, and Cl^-.

EFFECTS OF CADMIUM INGESTION AND FOOD RESTRICTION ON ENERGY
METABOLISM AND ITS ENDOCRINE CONTROL IN JAPANESE QUAIL.
Richard T. DiGiulio, Virgil E. Kopf, Patrick F. Scanlon and
Francis C. Gwazdauskas. Dept. Fisheries & Wildlife Sci.,
Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24060.

Twenty four Japanese quail, Coturnix coturnix japonica,
were randomly assigned to a 2 x 2 factorial experiment, the
factors being 50% food restriction vs. Ad libitum and 0
vs. 200 g cadmium (Cd) per g of food. The addition of 200
mg/kg cadmium (Cd) to the food of quail induced a food
restriction to approximately 40% of the intake of control
animals (7.22 ± 0.35 g/day Cd birds vs. 17.90 ± 0.39 g/day
control birds). The restricted - Cd treated birds, thus did
not consume all food provided. Compared to controls, the Cd
treated and restricted birds had significantly reduced body
weights, liver weights and omental fat stores ($P< .05$) after
14 days. The restricted birds had significantly ($P< .05$)
lower concentrations of plasma uric acid and glucose than
either the control or Cd fed group. In the Cd fed birds,
non-esterified fatty acids (NEFA) were significantly
($P<.05$) higher than either restricted group. Plasma
triiodothyronine (T_3) values were highest in the Cd group
and lowest in the restricted group with significant
differences ($P< 0.05$) among all groups. Thyroxine (T_4)
values were not different ($P> 0.05$) among groups. In
general, the metabolic intake of the cadmium-fed quail
appeared intermediate between controls and restricted birds,
the latter showed typical adaptations to energy restriction.

EFFECTS OF FOOD RESTRICTION AND CADMIUM INGESTION ON LIVER
GLYCOGEN STORES AND TISSUE WEIGHTS IN MALLARDS. Richard T.
Di Giulio*, and Patrick F. Scanlon. Dept. Fisheries &
Wildlife Sci., Va. Polytechnic Inst. & State Univ.,
Blacksburg, VA 24061.

The interactive effects of cadmium (Cd) ingestion and
food restriction were studied with a factorial design
consisting of 2 dietary levels, ad-libitum and 60 g food/
day (about 60% of ad-libitum), and 3 levels of Cd added
to the food - 0, 10, and 50 g Cd/g food. Each of 6 exper-
imental cells contained 8 adult mallard, Anas platyrhynchos,
drakes. The experimental diets were supplied for 6 weeks
after which the ducks were sacrificed. Across all food Cd
levels, restricted birds had significantly lower average
liver glycogen concentrations (11.8 mg/g vs. 41.6 mg/g,
$P < .05$) and lower total liver glycogen (171 mg vs. 727 mg,
$P < .05$) than ad-libitum birds. Restricted ducks also had
significantly lower final body weights (995 g vs. 1173 g,
$P < .05$), liver weights (13.5 g vs. 16.5 g, $P < 0.5$), kidney
weights (6.2 g vs. 6.9 g, $P < .05$), and paired testis
weights (18 g vs. 6.8 g, $P < .05$). The only observed effect
associated with dietary Cd level was a significantly reduced
($P < .05$) average packed cell volume (PCV) in ducks con-
suming the 50 µg Cd/g diet (PCV = 40%) compared to birds
fed the 10 µg Cd/g diet (PCV = 45%); birds eating rations
with no added Cd had an average PCV of 43%. Brain weights
and adrenal weights were not significantly different across
all treatment groups.

TISSUE METAL CONCENTRATIONS IN MALLARDS FED DIETS CONTAINING
CADMIUM AND/OR LEAD. Richard T. Di Giulio*, and Patrick F.
Scanlon. Dept Fisheries & Wildlife Sci., Va. Polytechnic
Inst. & State Univ., Blacksburg, VA 24061.

Groups of 8 mallards, Anas platyrhynchos, were placed on
one of 7 diets for 6 weeks. The diets were a commercial
starter-grower ration plus: 1) no metals, 2) 10 ppm lead
(Pb) in the food, 3) 100 ppm Pb, 4) 10 ppm cadmium (Cd),
5) 100 ppm Cd, 6) 5 ppm Pb and 5 ppm Cd, 7) 50 ppm Pb and
50 ppm Cd. At 6 weeks the ducks were sacrificed and dry
weight concentrations of Pb, Cd, Copper (Cu), and zinc (Zn)
were determined in livers, kidneys and ulnar bones by
atomic absorption spectrophotometry. Mean Cd concentrations
(µg/g ±S.E.) in liver ranged from 0.9 ± 0.1 in controls to
104.8 ± 1.91 in the 100 ppm Cd Group. Kidney Cd concentra-
tions ranged from 2.7 ± 0.3 in controls to 371.8 ± 22.3 in
the 100 ppm Cd group. Bone Cd concentrations were below
detection limits (0.06 µg Cd/g tissue) in all groups. Liver
Pb concentrations (µg/g) ranged from 0.1 ± 0.1 in controls
to 7.2 ± 0.9 in the 100 ppm Pb groups. Kidney Pb concentra-
tions ranged from 0.4 ± 0.3 to 22.5 ± 1.5, while bone Pb
concentrations ranged from 0.9 ± 0.6 to 5.3 ± 0.8 in the
same groups. Significant positive correlations between Cd
and Zn concentrations in liver and kidney and between Cd
and Cu concentrations in kidney may be indicative of an
adaptation involving the protective function the nutrient
elements Cu and Zn are thought to provide against Cd toxicity
and/or may be related to metallothionein induction.

HEAVY METAL CONCENTRATIONS IN LIVERS OF WATERFOWL HARVESTED BY MARYLAND HUNTERS. Richard T. Di Giulio*, Patrick F. Scanlon, Timothy J. Dietrick*, and Vernon D. Stotts*. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Dry weight concentrations of cadmium, copper, nickel and zinc in 604 livers from 13 waterfowl species were determined by flame atomic absorption spectrophotometry. Detection limits (d.l.) for the elements assayed, μg element /g liver, dry weight, were: cadmium, 0.08; copper, 0.32; nickel, 0.4; and zinc, 0.08. Copper and zinc were present at concentrations above d.l.'s in all samples and appeared to be within normal physiological ranges. Representative values for copper concentrations in different species, Mean (μg/g) ± S.E., N, were: Canada geese, 29.2 ± 2.0, 159; mallards, 50.4 ± 8.7, 114; black ducks, 34.6 ± 3.1, 103; white-winged scoter, 40.5 ± 3.6, 53; and oldsquaws, 20.7 ± 1.3, 30. Zinc concentrations in these samples were: Canada geese, 158.7 ± 6.9; white-winged scoters, 190.9 ± 31.8; and oldsquaws, 168.1 ± 13.7. The relatively high cadmium concentrations found in the livers of white-winged scoters and oldsquaws may be a function of their diets, which typically include a greater proportion of benthic invertebrates than the more herbivorous geese and puddle ducks.

THE FOOD HABITS OF BEAVERS IN SOUTHEASTERN VIRGINIA. JOHN L. ECHTERNACH*, Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

The food habits of a beaver colony in James City County, Va. were studied. Woody foods were determined by a tally of cut stumps. Some observations were made on use of herbaceous foods. Vegetation surrounding the colony was sampled using two by fifty m strip plots. Importance values were calculated for all trees, shrubs and saplings. Woody foods were given a utilization rank based on the number cut of a species and its relative density. A total of seventeen species were used as food by beaver. Of these, six species made up the bulk of the beaver's diet. These were Myrica cerifera, Liriodendron tulipifera, Cornus florida, Pinus virginiana and P. taeda (treated as one species), Fagus grandifolia, and Acer rubrum.

THE HABITATS OF THE SOUTHERN BOG LEMMING, SYNAPTOMYS COOPERI, IN THE GREAT DISMAL SWAMP. R. K. Everton* and R. K. Rose, Dept. of Biol. Sci., ODU, Norfolk, VA 23508

Using 0.25 hectare plots and pitfall traps, seven species of small mammals have been collected from meadow and forest habitats in the Great Dismal Swamp. Two rare endemic species (Synaptomys cooperi helaletes and Sorex longirostris fisheri) were among the three most numerous species to be collected from 10 study plots. At present Synaptomys and Sorex have been taken only in wet meadows and other non-forested habitats.

A BRIEF VIEW OF THE AGE DISTRIBUTION AND RECENT REPRODUCT-IVE POTENTIAL OF VIRGINIA BOBCATS. Richard B. Drinkwater,* and Burd S. McGinnes. Dept. Fisheries and Wildlife Science, Va. Polytechnic Institute and State Univ., Blacksburg, VA 24061.

The ages of 74 bobcats, Lynx rufus, collected between November 1979 and April 1981 were determined by analysis of tooth cementum layers. The mean age was found to be 2.82 years and the maximum age was 12.5 years. The reproductive tracts of 24 female bobcats were examined and placental scars counted. The mean litter size as judged from placental scar counts was found to be 2.33 with a minimum of 1 and a maximum of 4 scars. No evidence of breeding was found in any female less than 2 years old, based upon the absence of placental scars and corpora lutea. Females in all year classes above 2 years old showed evidence of recent breeding, the oldest being 12 years old. The sex ratio did not differ significantly form 1:1 males : females.

THE EFFECTS OF BIOGENIC AMINES ON GASTROINTESTINAL MOTILITY IN PERIPLANETA AMERICANA. D. F. Edwards, R. R. Mills, and T. D. Kimbrough. Dept. of Biology, Va. Common-wealth Univ., Richmond, Va. 23284

A baseline of contractile events, both in the full and empty gut from Periplaneta americana has been established using a standard physiological saline solution for insects. Similar intestinal contractility has been ob-served using Leucophaea maderae and Gromphadorhina porten-tosa. This has made possible the development of a sensi-tive tissue marker to a number of bioactive substances being measured. Among the agents that have been tested are acetylcholine, norepinephrine, and serotonin. Prelim-inary results are reported.

A SURVEY FOR HEARTWORM, DIROFILARIA IMMITIS (NEMATODA), IN DOGS FROM VIRGINIA AND NORTH CAROLINA. R.K. FALLS* and T.R. PLATT, Dept. of Biology, Univ. of Richmond, Richmond, Va. 23173.

One hundred dogs, collected from county pounds in Vir-ginia and North Carolina, were surveyed for the presence of microfilariae of Dirofilaria immitis in the blood. Micro-scopic examination of fresh thin-films and modified Knott preparations were made. Dirofilaria immitis and Dipetalonema reconditum were found in 19% and 6% of the animals, respec-tively. No animals harbored both species concurrently.

Prevalence was significantly higher in North Carolina (26.8%) than in Virginia (13.6%) ($p < .025$). In North Carolina, there was a higher prevalence of infection in Edgecomb and Cleveland counties than in Rowan, Davie and Gaston counties ($p < .05$). No animals in Davie and Gaston counties were infected. Dirofilaria was present in the four counties in Virginia; Halifax, Hanover, Henry and Mecklen-burg. No significant were found between these locales.

Mean packed cell volumes were significantly lower ($p < .0005$) in infected versus non-infected animals.

ARTHROPOD ASSOCIATES OF THE COBRA LILY (*DARLINGTONIA CALIFORNICA*). N. J. Fashing. Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185

The Cobra Lily, *Darlingtonia californica*, is an endangered species of pitcher plant with a patchy distribution along the Oregon coast and in the southern portion of the Cascades. A number of species of arthropods exploit this plant by living in its pitchers. Three species feed on the decomposing arthropods captured by the plant. These include the larvae of *Metriocnemus edwardsi* (Chironomidae, Diptera), *Megaselia orestes* (Phoridae, Diptera) and the post-embryonic instars of *Anoetus* sp. (Histiostomatidae, Acari). The larvae of *Botanobia darlingtoniae* (Chloropidae, Diptera) are reported to do the same, but were not recorded in this study. Spiders, primarily *Eperigone trilobata* (Linyphiidae), construct webs in the domes of the pitchers near the entrances and capture small insects entering the pitchers. *Proterewnetes* sp. (Eupodidae, Acari) utilize the protected area under the nectar roll for egg laying, and the post-embryonic instars forage on the wall of the pitcher above the water line. *Leipothrix* sp. (Eriophyidae, Acari) and *Tarsonemus* (?) sp. (Tarsonemidae, Acari) feed above the water line on the tissue of the pitcher itself. *M. orestes*, *E. trilobata*, and the four mite species are new records for this habitat, and at least two of the mite species (*Anoetus* sp. and *Leipothrix* sp.) are new. Most of the species are obligate inhabitants of the pitchers of the Cobra Lily.

CHARACTERIZATION OF UREAPLASMA UREALYTICUM ISOLATES FROM HUMAN SEMEN. Randy Fischer† J.W. Edward Wortham, Jr., and R. D. Cintron† Andrology Laboratory, Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

Ureaplasma urealyticum (T-mycoplasma) has been implicated by numerous investigators as a possible etiological agent of urogenital tract disease and various instances of reproductive wastage since its isolation from patients with nongonococcal urethritis in the early 1950s. Data has been presented which suggests that alterations in specific semen parameters could be associated with the presence of U. urealyticum in males under examination for suspected subfertility. However, other researchers, including members of the Old Dominion University Andrology Laboratory have conducted similar experiments and have determined that subfertile males with U. urealyticum in their semen do not have a decrease in semen quality when compared to those lacking this organism. This laboratory is engaged in a more comprehensive study in an attempt to determine if pathology may be related to the titer of infecting organisms and/or associated with a particular serotype. Our preliminary data suggests that titers of U. urealyticum range from approximately 2.0×10^1 to 4.7×10^4 CFU/ml in infected semen. Secondly, there appears to be a relationship between titer level and colony size. Thirdly, a limited number of colony characteristics will be compared between the three district serotypes isolated from semen in this laboratory.

FREQUENCY RESPONSE OF THE TOADFISH SWIMBLADDER. M. L. FINE*. DEPT. OF BIOLOGY, VIRGINIA COMMONWEALTH UNIV., RICHMOND, VA. 23284

Utilizing an acoustic pressure field and a vibration detector, the frequency response of the swimbladder of the oyster toadfish was measured from less than 50 to 1000 Hz. Not only was there no evidence of resonance, the swimbladder in the intact fish provided no gain over the same fish with its swimbladder filled with water. Therefore, the swimbladder does not appear to determine the frequency response of the fish's hearing or of the sounds it produces. Lack of swimbladder resonance is consistent with the temporally-based system of communication employed by the oyster toadfish.

CHANGES IN ADRENAL HISTOLOGY AND PLASMA ALDOSTERONE ACCOMPANYING OSMOTIC STRESS IN THE MONGOLIAN GERBIL(MERIONES UNGUICULATUS). G.H. Freeman and F.B. Leftwich*. Dept. of Biology, Univ. of Richmond, VA., 23173

The Mongolian Gerbil demonstrates remarkable adaptability to osmotic stress. Not only can it tolerate the ad lib drinking of 6.0% NaCl, but it almost totally reabsorbs sodium in the lack of environmental sodium. It has been suggested that an atypical adrenocorticoid may be involved. Plasma aldosterone has not been previously examined.

Gerbils forced to rely on 6.0% NaCl as drinking solution lost weight rapidly, hemoconcentrated, and demonstrated elevated numbers of zona fasciculata mitotic figures. Zona glomerulosa atrophy was not observed. Plasma aldosterone was diminished in the first three weeks and demonstrated an increase by the ninth week. A reversal of dehydration was noted by the ninth week.

Sodium chloride deprivation did not induce glomerulosa hypertrophy. Plasma aldosterone was uniformly elevated.

Fasciculata mitotic figures in sodium chloride stressed gerbils implicate glucocorticoid secretion as an important stress prophylactic.

DISRUPTION OF SEX PHEROMONE ACTIVITY IN DERMACENTOR ANDERSONI STILES AND D. VARIABILIS (SAY) BY QUINONES. D.M. Gainsburg*, D.E. Sonenshine, P.J. Homsher, and W.T. Bullard*. Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

Disruption of sex pheromone activity in the Rocky Mountain wood tick, Dermacentor andersoni Stiles, and the American dog tick, D. variabilis (Say), was achieved with injections of quinones into the female of the species. Histochemical studies, comparison of the ultrastructure, and chlorine content of the foveal glands, the site of pheromone storage, indicate changes in the cellular composition of this tissue. (Aided by NIH grant AI 10986.)

MORPHOGENESIS OF LYMPHOCYTES IN REDUCED FETAL CALF SERUM MEDIUM, Patricia Goad, Bernard Parker, and Evelyn Jemison, Cytogenetics Laboratory, Department of Life Sciences, Virginia State University, Petersburg, Virginia 23803

A new medium with donor plasma fractions as a fetal calf serum substitute or supplement is being developed for lymphocytes growth. Phytohemagluttin stimulated lymphocytes are cultured from peripheral blood fractions collected in sodium citrate vacutainers. Previous results of this experiment established twelve percent fetal calf serum with tissue culture medium 199 which produced optimum growth for bioassay. Lymphocytes transformation and chromosomal configuration were used as parameters in comparing the effectiveness of the medium. Results: twelve percent fetal calf serum (FCS) promoted optimum growth of lymphocyte cells, eight percent (FCS) with four percent autologous plasma supplement was effective for maintenance of leucocyte cultures for 48 hours only, four percent FCS with eight percent autologous plasma did not promote enough blastogenic and mitogenic response or cell maintenance as needed for bioassay. (Supported by NIH/MBS Grant SO6-RR-08090-09).

INFLUENCE OF PHOTOPERIOD AND NUTRITION ON BODY WEIGHT AND REPRODUCTIVE ORGAN WEIGHTS IN THE PINE VOLE. J.J. Hasbrouck*, R.L. Kirkpatrick, A.R. Tipton, and J.A. Cranford. Depts. of Fish and Wildl. Sci. and Biology, VPI&SU, Blacksburg, VA 24061

The influence of nutrition and photoperiod on reproductive performance of the pine vole (Microtus pinetorum) was examined in two experiments. In the first, two males and five females were placed in concrete troughs (2.3m^2) for 12 weeks. Half of the groups were kept on a 14:10 photoperiod and the remainder on a declining photoperiod. Within each lighting regime, half of the groups were given apples as a dietary supplement. All groups received ad libitum amounts of rabbit chow. Mean weights for seminal vesicle, testes, uterus and paired ovaries were significantly lower (P<0.05) in voles on the declining photoperiod. Mean testes weight and female mean body weight were significantly increased (P<.05) with an apple supplement. The second experiment was conducted in an environmental chamber. Male-female pairs with a known reproductive history were separated into two groups, one on a 9:15 and the second on a 15:9 photoperiod. Within each photoperiod, half of the pairs were given an apple supplement. All pairs were fed ad libitum quantities of horse chow. The experiment ran only 4 weeks due to technical problems. Mean seminal vesicle weight was significantly lower (P<.01) in males on the 9:15 photoperiod. Males on a chow diet had a significantly higher (P<.05) mean body weight and mean seminal vesicle weight.

SELECTION FOR REDUCED SEXUAL ATTRACTION IN THE IXODID TICK DERMACENTOR VARIABILIS (SAY). P. J. Homsher and D. E. Sonenshine, Dept. of Biological Sciences, ODU, Norfolk, VA 23508.

The sex pheromone of the American dog tick, Dermacentor variabilis (Say) has been identified as 2,6-dichlorophenol. This chemical is found complexed with a neutral lipid in the foveal glands of the female and is released through the foveae dorsales when stimulated by the feeding process in the adult tick. The objective of this study was to determine if some part of the synthesis or release mechanisms could be selected against to produce females that were unattractive. Four generations of selection for the least attractive females resulted in producing only three females in the only line that remained by then. These females were difficult to mate (requiring the addition of the sex pheromone to the external dorsal surface in one) and, although all three laid eggs, two egg clutches had no viable embryos and one had 54 of 1961 eggs hatch (2.8%). However, foveal glands from these females were found to have a normal amount of 2,6-dichlorophenol (2.6ng/tick), indicative that the selection observed affected the release mechanism for the pheromone rather than the synthesis mechanism.

EFFECTS OF GALVANIZED VERSUS STAINLESS STEEL CAGING ON LIVER AND KIDNEY CONCENTRATIONS OF TRACE METALS IN WHITE MICE. Edwin J. Jones* and Richard T. DiGiulio*. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061

Liver and kidney trace metal concentrations were determined in ICR mice raised in stainless steel (SS) and galvanized (GAL) hanging cages. Six and 9 weanling mice were housed in pairs in SS and GAL cages, respectively, for 12 weeks. No differences were observed between groups in initial body weight, final body weight, liver weight, and paired kidney weight. Liver and kidney dry weight metal concentrations were determined by flame atomic absorption spectrophotometry. A significant difference (P=0.03) was observed in liver zinc (Zn) concentrations between GAL (83.86 $\pm$ 5.77μg/g; $\bar{X}$ $\pm$ S.E.) and SS (55.60 $\pm$ 11.03) groups. Liver copper (Cu) tended to be higher in GAL (13.98 $\pm$ 1.80) than in SS (11.06 $\pm$ 1.88). Only 1 mouse in each group had detectable liver cadmium (Cd). Kidney Zn concentrations tended (P=0.18) to be higher in GAL mice (86.25 $\pm$ 18.71) than in SS mice (53.40 $\pm$ 7.65). GAL kidney Cd was higher than SS kidney Cd (0.20 $\pm$ 0.05 vs. 0.06 $\pm$ 0.06; P=0.09). No difference was observed in kidney Cu between groups (GAL 10.96 $\pm$ 0.91; SS 9.10 $\pm$ 1.33).

It is recommended that stainless steel cages be used when trace metals may be a factor in view of the greater amounts of kidney Zn and Cd and liver Zn observed in the mice raised in GAL cages.

CAGE CULTURE OF CHANNEL CATFISH AND RAINBOW TROUT IN A VIRGINIA POND. Louis A. Helfrich* and Richard E. Kreh* Dept. of Fisheries and Wildlife Sciences, VA Polytechnic Inst. and State Univ., Blacksburg, VA 24061

To evaluate the biological feasibility of a double fish-crop rotational system in Virginia's warmwater farm ponds, channel catfish (Ictalurus punctatus) and rainbow trout (Salmo gairdneri) were reared in cages (1m^3) suspended in a pond at the Reynolds Homestead Agricultural Station, Patrick County, Virginia. Channel catfish fingerlings (127mm), stocked in June at a density of 100 fish per cage (n=6 cages) were harvested in late October. During the 124 day growing season at a mean water temperature of 25°C, yield, net production, food conversion, and survival of channel catfish averaged 20 kg, 16 kg, 2.02, and 84 percent per cage, respectively. Production and food conversion of channel catfish reared on a diet of commercial trout feed were significantly greater (P<0.05) than those fed commercial catfish feed. Rainbow trout fingerlings (127mm), stocked in November at a density of 200 fish per cage (n=2 cages) were sampled in March. After a 136 day winter growing season at a mean water temperature of 6°C, yield, net production, food conversion, and survival of rainbow trout averaged 31.0 kg, 8.6 kg, 4.50 and 94 percent per cage, respectively. The results indicate that double-cropping of channel catfish and rainbow trout in cages in Vriginia ponds is biologically feasible. Large-sized fingerlings (>150mm) and high stocking densities (>250 fingerlings/cage) are recommended.

CYTOGENETIC AFFECTS OF CYCLAMATES. E. W. Jemison, K. Brown*, and B. Rivers*. Dept. of Life Sciences, Va. State Univ., Petersburg, Va. 23803

PHA-stimulated human peripheral lymphocytes were used as a model system for assessing the in vitro effect of calcium cyclamate. Techniques of autoradiography, cytological staining, cell counting, liquid scintillation and karyotyping were used to study the cytogenetic damage and biochemical effects of calcium cyclamate when assayed at 24 hour intervals for 96 hours. The cells were exposed to 10^{-2} and 10^{-3} molar concentrations of calcium cyclamate in TC 199 medium with fetal calf serum and antibiotics.

Data obtained from this study indicated that calcium cyclamate impaired the synthesis of deoxyribonucleic acid (depicted by decreased incorporation of radioactive thymidine into acid precipitable material), reduced grain counts in autoradiographs and increased chromosome aberrations in cyclamate treated PHA-stimulated peripheral blood lymphocytes in vitro. Morphological changes and growth rate showed significant effects. (Supported by Minority Biomedical Support Program, NIH Grant 1 S06 RR-08090-0).

BLOOD PROTOZOANS OF JUVENILE MOURNING DOVES FROM MONTGOMERY COUNTY, VIRGINIA. Edwin J. Jones*, Ralph E. Mirarchi*, and Patrick F. Scanlon. Dept. Fisheries and Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Blood smears from 48 juvenile mourning doves, Zenaida macroura, collected in Montgomery County, Virginia during August and September 1977 were examined for blood parasites. Gametocytes of 3 species were observed: Haemoproteus sacharovi, Haemoproteus maccallumi, and Leucocytozoon marchouxi. H. sacharovi was observed in only 1 dove. H. maccallumi and L. marchouxi were observed in 10 and 4 doves, respectively. Two mixed infections were observed. One dove harbored both H. sacharovi and H. maccallumi, the other mixed infection was H. maccallumi and L. marchouxi. All infected doves had less than 5 gametocytes per 10,000 erythrocytes except 2 doves infected with H. maccallumi which had 69 and 90 gametocytes per 10,000 erythrocytes.

AN EVALUATION OF ENVIRONMENTAL VARIABLES IN BROWN TROUT STREAMS OF VIRGINIA. Theresa A. Keklak* and Richard J. Neves.* Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061.

Brown trout have been stocked in Virginia streams since 1962. While the establishment of brown trout fisheries tends to enhance fishing quality, no extensive studies have been made to identify reasons for the success or failure of these introductions. The objective of this study was to determine characteristics of Virginia streams most likely to support self-sustaining brown trout populations. The physico-chemical conditions of six streams containing brown trout were studied in order to evaluate the relationship between these factors and brown trout populations. Study streams varied in fish population abundance, vegetation type, temperature, flow, gradient, width, depth, and habitat quality. Forty-one environmental attributes were measured at study sites on each stream. Those parameters significantly correlated (P<.05) with brown trout biomass were used to develop multiple regression models. Of the environmental variables measured, brown trout biomass on two sampling dates (June and November) was closely correlated with alkalinity, hardness, conductivity, total phosphates, percent canopy, percent gravel sediment type, and percent rubble sediment type.

XYLAZINE HYOROCHLORIOE FOR RESTRAINT OF WHITE- TAILEO DEER. Virgil E. Kopf, Oavid F. Gibson, Timothy J. Oietrick, Patrick F. Scanlon and Roy L. Kirkpatrick. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. and State University, Blacksburg, VA 24061

Restraint facilitating drugs offer the opportunity for safe, and humane intensive physiological investigation under penned conditions. Drugs can alter physiological characteristics either directly or indirectly. Clinical effects of xylazine hydrochloride (XHCl) on white-tailed deer, *Odocoileus virginianus*, were investigated at dosage rates ranging from 3.3 mg/kg B.W. to 0.1 mg/kg. Oeer generally were capable of standing within 2-3 hours after injection. Oeer at higher dosages had protracted recovery times. At high dosage rates (3.3 mg - 2.9 mg/kg) feed intake was reduced from 5-7 days after treatment. Feed intake at lower dosage rates (0.5, 0.25, and 0.1 mg/kg) were generally depressed for a period of 1-2 days after treatment. XHCl at low dosage rates provides a means for intensive physiological investigation in penned animals with nominal and predictable impacts on clinical and physiological characteristics together with reasonable safety for deer and personnel.

EFFECTS OF XYLAZINE HYOROCHLORIDE ON THYROXINE ANO TRIIOOO-THYRONINE IN WHITE-TAILEO OEER. Virgil E. Kopf, David F. Gibson, Anne Oelschlaeger, Patrick F. Scanlon, Roy L. Kirkpatrick and Francis C. Gwazdauskas. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Nine white-tailed deer does were subjected to two techniques for blood collection. Blood was withdrawn during manual restraint (0 time) followed by three subsequent withdrawals during manual restraint at 15, 30, and 90 mins. after the initial restraint. The second technique was manual restraint (0 time) with injection of xylazine hydrochloride (XHCl) at the rate of 2.90 ± 0.15 mg/kg B. W. Subsequent collections were made at I5, 30, and 90 mins. after the XHCl injection. The values for circulating levels of thyroxine (T_4) and triiodothyronine (T_3) were examined for effects resulting from the method of restraint (manual vs. drug) and the time after initial restraint (0, 15, 30, 90 minutes). Analysis of variance indicated that neither the restraining technique nor the time since initial restraint significantly (P> 0.1) affected the circulating values of the hormones. (Supported in part by Pratt Animal Nutrition Foundation).

A NEW BIOLOGY: USING STRESS AS A TOOL FOR HEALTH AND CRIME. Michael P. Kradz and John C. Bartone, The American Health Research Institute, Annandale, Virginia 22003.

"Stress" has an indisputable role in health and crime and can be considered as a conglomerate quantum of which any particle can affect any life process of any human be it external or internal. The "stress of life" is an accoutrement of all aspects of human endeavor besides evolutionary and its multivariate facets can be demonstrated although experimentally it can be approached as a composite entity. Stress as a "tool" need not be confined by mechanisms as proposed by Selye (1956) nor limited by the monograph works of *Social & Psychological Factors in Stress* as edited by McGrath (1970). The autonomic and physiologic responses retain their specificity. Stress *Per se* is used as a biological tool *in toto* irrespective of source and composition, and is made possible by use of an instrument known as the Psychological Stress Evaluator (PSE).

New cases and current human research is presented by use of the PSE to demonstrate that PSE-detected stress has enabled the revelation, detection and isolation of (1) guilt and hostility; (2) substance abuse as alcoholism and nicotine (3) drug abuse as misuse of perscription medication; (4) academic cheating; (5) isolated and simple shop-lifting by students, and the (6) stress of telling lies.

Stress has been found to exist as an acute or as a chronic presence in human subjects with varying levels of low to high intensity irrespective of all other factors. Stress has been found pervasive and rendered some subjects useless.

DISTURBANCES IN TRYPTOPHAN METABOLISM IN OSBORNE-MENDEL RATS. T. D. Kimbrough, L. B. Weekley, and M. L. Jones. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

In a comparative study of two rat strains fed a normal diet, parameters of normal tryptophan (Trp) and serotonin (5-HT) metabolism were measured. In comparing genetically obese Osborne-Mendel rats (O-M) to Sprague-Dawley rats (S-D), the former strain was found to have decreased hepatic tryptophan 2,3 dioxygenase (TO) activity, while hepatic tyrosine amino transferase (TAT) activity was not significantly different. In a brain Trp uptake and 5-HT synthesis rate study, the S-D telencephalon had higher Trp levels, while the converse was observed in the brain stem. The brain 5-HT synthesis rate appeared to be reduced in the S-D brain stem relative to the O-M rat, and the O-M telencephalon may account for the hyperphagia and obesity that occurs in the O-M rat.

SOME ASPECTS OF DIETARY ZINC LEVELS AND AFLATOXICOSIS IN FISCHER RATS. J. M. Kinzie* and G. C. Llewellyn. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

Both high and low zinc diets have been linked to possible reduction in neoplasms. Aflatoxins are potent, common natural hepatocarcinogens implicated in both animal and human acute toxic neoplastic cases. This study was undertaken to determine the possible effects of dietary zinc levels on aflatoxicosis. Thirty-six weanling male Fischer rats divided into six groups received 15, 50 (control) or 1000 ppm Zn^{++}, or 15, 50 or 1000 ppm Zn^{++} with 13.9 ppm mixed aflatoxins having 2.5 ppm as AFB_1 in Bio-Mix #883 (Bio-Serv Inc.) for 92-95 days. No reductions in hepatic neoplasms were observed with the zinc levels used. Cytochrome P-450 concentrations in the livers were decreased in the aflatoxin treated rats. The combination of high zinc and aflatoxin produced the lowest level of total cytochrome P-450. Competitive binding of aflatoxin to the cytochrome preventing formation of the CO-cytochrome P-450 complex or a loss of heme synthesis are possible explanations for this effect. Both low and high levels of zinc reduced histopathological effects in the kidneys of the rats, the latter most effectively. The better results in this respect with the high zinc levels may have been the result of altered AFG_1 metabolism to a less toxic product.

INFLUENCE OF ACUTE COLD SHOCK ON ACETAZOLAMIDE-SENSITIVE ESTERASE ACTIVITY IN THE BLUEGILL SUNFISH (LEPOMIS MACROCHIRUS). Stephan R. Larrick, Donald S. Cherry* and John Cairns, Jr., Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508 and Center for Environmental Studie Studies - Biology Dept., Va. Polytechnic Inst., Blacksburg, Va., 24061.

The physiological response of bluegill sunfish (Lepomis macrochirus) to a rapid cold shock was investigated. The critical thermal minimum (CTMin) for juvenile fish acclimated at 20 degrees C was 6.7 degrees C. Acetazolamide-sensitive esterase of branchial homogenates from 20 degrees C acclimated juvenile bluegill was 1.32 mmoles p-nitrophenyl acetate cleaved/min-mg protein. The specific activity declined to a low of 0.32 mmoles/min-mg, 21 hours after the cold shock, but increased to 1.28 mmoles/min-mg after two weeks in 8 degree C water. Activity in control fish was highest in the blood, followed by the swim bladder, liver, kidney, gill, spleen and gonads of bluegill sunfish.

A plot of reaction velocity versus substrate concentration suggested that quantitative and possibly qualitative differences between the enzyme complement from 20 to 8 degree C acclimated fish exist. Polyacrylamide gel electrophoresis (PAGE) demonstrated that no new isozymes were induced. The differences between catalysis observed in warm and cold-acclimated bluegill was probably a result of differential rates of synthesis of the two isozymes that were already present.

THE INFLUENCE OF INORGANIC IONS ON THE OXYGEN BINDING CHARACTERISTICS OF HEMOCYANIN IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN. Richard P. Mason* Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185

Aliquots of blood extracted from adult male blue crabs were dialyzed for 48 hours against various buffered (0.05 M Tris Maleate) solutions that contained common ions found in seawater. Intially, the effects of total salinity were examined. The results demonstrate that increases in inorganic ion concentration cause the respiratory pigment, hemocyanin, to bind oxygen more readily. In subsequent experiments the ionic constituents were isolated to determine which inorganic ions influence the binding of oxygen by hemocyanin. The results show that Ca^2, Mg^2 and to a lesser extent Na are responsible for the observed oxygen binding in native blood.

CHROMOSOME/CYTOPLASMIC INTERACTIONS AFFECTING SENSITIVITY TO AFLATOXIN B_1 TOXICITY IN DROSOPHILA MELANOGASTER Pamela D. Melone* and Joseph P. Chinnici,

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Chromosome/cytoplasm substitution shows that resistance to aflatoxin B_1 as measured by egg to adult survival rates is genetic in Drosophila melanogaster and that chromosome 2 contains the majority of the resistance genes, chromosome 3 has no effect, and the effect of chromosome X depends on the type of cytoplasm present. Resistance also appears to be augmented by a cytoplasmic factor. Strains with a resistant chromosome 2 are more resistant to increasing aflatoxin concentrations if the cytoplasm is also resistant. Strains with a resistant third chromosome survive at a low rate only if the cytoplasm is resistant. This pattern appears to be reversed in the resistant X chromosome strains. If all chromosomes are sensitive, a cytoplasmic effect is not seen, but if all chromosomes are resistant the type of cytoplasm present effects survival rates so that flies with resistant cytoplasms survive at a higher rate.

THE INFLUENCE OF SOIL TEXTURE AND SOIL MOISTURE ON SOUTHERN CORN ROOTWORM LARVAE. P. F. Lummus* and J. C. Smith. VPI & SU, TRACEC, Suffolk, VA 23437.

In a growth chamber study involving 4 Virginia soils and 4 moisture regimes, survival of larvae of southern corn rootworm, Diabrotica undecimpunctata howardi Barber increased as percentage clay content and percentage plant available water increased. The percentage clay content of the 4 soils ranged from 5 to 10. The lower depletion limits of the 4 moisture regimes and their respective full points were 20-30, 45-55, 70-80, and 90-100 percent of plant available water. A sharp decrease in survival was noted in the 2 lower moisture regimes, suggesting a critical plant available water value between 50 and 75 percent.

GENETIC INVESTIGATION OF ENDRIN RESISTANCE IN PINE VOLES USING STARCH-GEL ELECTROPHORESIS. J.E. McBride*, R.L. Kirkpatrick, J.J. Ney, and A.R. Tipton. Dept. of Fish. and Wildlife, VPI&SU, Blacksburg, Va. 24061.

Pine vole (Microtus pinetorum) populations in 6 southwestern Va. apple orchards were sampled to relate the degree of endrin resistance or susceptibility present to population genetic differences. About 75 voles were trapped, before and after winter endrin application, in each of 3 orchards that had been annually sprayed with endrin for the last 15 yrs. and in 3 never-treated orchards. Oral endrin LD_{50} determinations revealed no apparent differences between treated and untreated orchards before spraying. LD_{50}'s ranged from 2.6-6.4 mg/kg b.w. These values were comparable to LD 50's for endrin-susceptible voles found in the literature. After spraying, LD_{50}'s in 2 unsprayed orchards were 0.6 and 3.0 mg/kg; in 2 sprayed orchards, they were 6.0 and 16.8. Four polymorphic enzyme markers were electrophoretically analyzed, 2 of which (GOT and LDH) were reported to increase in activity after endrin dosage. Two other loci (IDH and MDH) were arbitrarily chosen as random representations of the genome. In the before-spraying samples, no apparent differences in mean individual heterozygosity [no. heterozygotes/(no. individuals)(no. loci)] consistently occurred between populations from sprayed or unsprayed orchards for any combination of loci surveyed: GOT and LDH, IDH and MDH, or all 4 loci together.

AMPHIBIANS AND REPTILES OF VIRGINIA PROJECT: COMMENTS AND UPDATE. Joseph C. Mitchell, Dept. of Biology, Univ. of Richmond, Richmond, VA 23173 and Christopher A. Pague, Lafayette Zoological Park, 3500 Granby St., Norfolk, VA 23504.

Virginia has a rich amphibian and reptilian fauna consisting of 127 species, 52% amphibians and 48% reptiles. Perhaps due to this diversity a summary volume of our knowledge of these animals has not been published. Since 1979 we have been gathering natural history data on each species with the ultimate goal of publishing a book-length summary of this information. Data collected for each species include locality records, phenotypic variation, size variation, food habits, reproductive attributes, habitat, behavior, etc. Sources of information include analyses of museum collections, field studies and the literature. To date we have examined specimens in 5 university and museum collections and have amassed field data on about 5000 specimens. Specimens collected in our efforts will be deposited in the National Museum of Natural History, which is supporting our field work. Specific studies include projects on the ecology of Virginia's freshwater turtles and an intensive survey of the herpetofauna of Back Bay National Wildlife Refuge.

SOME ASPECTS OF THE POPULATION ECOLOGY OF THE FRESHWATER TURTLES CHRYSEMYS PICTA AND STERNOTHERUS ODORATUS IN VIRGINIA. Joseph C. Mitchell, Dept. of Biology, Univ. of Richmond, Richmond, VA 23173.

Populations of Chrysemys picta (Painted turtle) and Sternotherus odoratus (Stinkpot) have been studied by mark-recapture for two years in Laurel Lake, Henrico Co., VA. The system is eutrophic and consists of the lake, a section of Hungary Creek and a beaver pond. Population size estimates are 983 for C. picta and 822 for S. odoratus. Sex ratios are 1:1.1 (mature males to females) for C. picta and 1:1.2 for S. odoratus. Preliminary analysis indicates a stable to growing population of C. picta and a stable to declining population of S. odoratus. Male C. picta mature at 5 years; 3 years for S. odoratus males. Female C. picta mature at age 7, bear 2 clutches of 3-5 eggs per clutch each year, and are long-lived (some females are 20+ years of age). Female S. odoratus mature at age 4 and bear 2-3 clutches of 2-6 eggs per clutch per year. Few live past 10 years of age. Community associates are Chelydra serpentina (Snapping turtle), Pseudemys rubriventris (Red-bellied turtle), Kinosternon subrubrum (Eastern Mud turtle), and Clemmys guttata (Spotted turtle).

EFFECTS OF NUTRITION AND PCB EXPOSURE ON SELECTED BLOOD CHARACTERISTICS OF RACCOONS AND OPOSSUMS. W.E. Montz, Jr.,* W.C. Card,* and R.L. Kirkpatrick. Dept. of Fisheries and Wildlife Sciences, VPI&SU, Blacksburg, Va. 24061

Two studies were conducted to determine the effects of nutritional restriction and polychlorinated biphenyls (PCB's) on sodium pentobarbitol-induced sleeping times (ST) and selected blood characteristics in raccoons (Procyon lotor) and opossums (Didelphus marsupialis). Sixteen wild-trapped raccoons were used in a 2x2 factorial experiment and were fed either ad libitum or 70% ad libitum and 0 or 50 mg Arochlor 1254/kg body weight. After 10 days on treatment, ST's were determined, the animals sacrificed, and blood and kidney fat samples taken for analysis. Ingestion of PCB's severely reduced food consumption. Mean serum concentrations of β-hydroxybutyrate were higher in restricted animals (P=0.05) and in those given PCB's (P<0.10). Serum cholesterol levels were reduced by PCB exposure. Body weight gains were significantly greater for animals not exposed to PCB's. Neither non-esterified fatty acid concentrations (NEFA), aceotacetate concentrations, or ST's were altered by feed level of PCB exposure (P>0.10). Eleven juvenile opossums received either 0 or 50 mg Arochlor 1254/kg body weight for 9 days. Mean NEFA concentrations were significantly higher (P=0.01) in animals given PCB's. No differences were noted in either ST's, body weight changes, or cholesterol concentrations (P>0.10).

ISOLATION AND CHARACTERIZATION OF APOLIPOPROTEIN B STUDIES TO EVALUATE THE POSSIBILITY OF A GENETIC VARIANT. C.L.Morey*, T.L.Thompson*, and M.F. Pinkston. Dept. of Chemistry, Mary Baldwin Col., Staunton, VA 24401.

It is hypothesized that the development of delayed-type hypersensitivity reactions following ingestion of certain foods containing highly saturated triglycerides may result from alteration in one of the plasma lipoproteins responsible for triglyceride transport in body fluids. Preliminary electrophoretic studies have indicated that apolipoprotein B (Apo B) in a sensitive person may differ from the control. Apo B, the major protein moiety of low density lipoproteins (LDL) is characterized by extreme insolubility in aqueous solutions and tendency to aggregate when the LDL fraction is delipidated with organic solvents. Isolation of Apo B from the affected subject and normal controls is effected by precipitation with heparin and $MgCl_2$ followed by extraction with ethanol/diethyl ether. The residual apolipoprotein is solubilized with 6M guanidine chloride and cupric ammonia complexes and further purified by gel permeation chromotography in preparation for electrophoresis and isoelectric focusing. Results of electrophoresis of water solubilized Apo B appear to support the hypothesis of a genetic variant.

A MICROCOSM STUDY OF THE INTERACTIONS OF CADMIUM AND SEDIMENTS IN AQUATIC SYSTEMS. C. K. Moses* and C. L. Thomas. Dept. of Biology, Ferrum College, Ferrum, Va. 24088

A microcosm study of the interactions of sediments and cadmium in four liter polyproplene containers was performed at Ferrum College This study was designed to answer the question: how does the presence of sediments affect the perturbation of an aquatic system by a heavy metal (cadmium)? In this study, lasting ten weeks, it was found that the presences of sediments may reduce long-term toxicity of a heavy metal and that the sediments and cadmium may interact to yield higher production as measured by three point dissolved oxygen readings.

HOW DO PARTULA SPECIES PARTITION THEIR HABITAT? James Murray, Dept. of Biology, Univ. of Va., Charlottesville, Va. 22901, Michael S. Johnson, Dept. of Zoology, Univ. of Western Australia, Nedlands, Western Australia 6009, and Bryan Clarke, Genetics Research Unit, The Queen's Medical Centre, Clifton Boulevard, Nottingham NG7 2UH, England

Despite their close genetic relationships the species of land snails of the genus Partula on Moorea in French Polynesia often occur together. We have studied two sites with four species each. Partula suturalis, P. mirabilis, and P. taeniata are found at each site. P. mooreana and P. tohiveana complete the sets. For each snail we recorded its host plant, its location, and its relation to other snails. The variables were subjected to discriminant analysis.

The snails are not distributed at random. P. suturalis is arboreal, mostly on Hibiscus tiliaceus. P. taeniata is more generally distributed closer to the ground, on woody shrubs and the fern Angiopteris. P. tohiveana and P. mooreana are strongly associated with climbing pandanus Freycinetia demissa. P. mirabilis is interm ediate in position.

The species are well separated by the discriminant analysis except for P. mirabilis and P. mooreana. The remarkable success in identifying P. mooreana from the functions developed using P. tohiveana demonstrates that these two species are ecological equivalents. (Aided by the Australian Research Grants Committee (D1-77/15705), the National Science Foundation (2AS-30), and the Science Research Council.

A HERPETOFAUNAL SURVEY OF BACK BAY NATIONAL WILDLIFE REFUGE: A PRELIMINARY REPORT. Christopher A. Pague, Lafayette Zoological Park, 3500 Granby St., Norfolk, VA 23504 and Joseph C. Mitchell, Dept. of Biology, Univ. of Richmond, Richmond, VA 23173.

Back Bay National Wildlife Refuge is located in the southeast corner of Virginia and is composed of barrier beaches, slightly brackish Back Bay, and small islands within Back Bay. A survey of the amphibians and reptiles now in progress has confirmed the presence of 26 species, 8 amphibians and 18 reptiles. Several other species are thought or known to be present. However, many conspicuous members of the southeastern Virginia herpetofauna are apparently absent, including: Sternotherus odoratus, Clemmys guttata, Sceloporus undulatus, Eumeces spp., Thamnophis sirtalis, Diadophis punctatus, Agkistrodon contortrix, Plethodon spp., Eurycea spp., Ambystoma spp., Acris spp., Hyla chrysoscelis, Rana palustris, and Rana clamitans. In fact, approximately 50% of southeast Virginia's herpetofauna is not found on the refuge. This may be attributed in part to the long term ecological changes accompanying postglacial coastal inundation. Data are being collected on the reproductive biology and ecology of as many species as possible, especially within the context of the effects, if any, of the habitat management for waterfowl. It is apparent that habitat management has had a large effect on turtle ecology.

DISMAL SWAMP MAMMALS - PAST. R.K. Rose, Dept. of Biological Science, Old Dominion University, Norfolk, VA 23508.

Although the history and lore of the Great Dismal Swamp is rich with accounts of abundant wildlife of many kinds, relatively few studies of birds and mammals have been conducted there. The investigations of mammals in the 1895-1898 period by the U.S. Biological Survey were followed by less intensive surveys, mainly in the thirties and fifties. The Swamp, it turns out, does have a handful of mammals not found elsewhere in Virginia, including five distinctive subspecies. Habitat changes in the Swamp may be favoring some species and hurting others.

EFFECTS OF FORMALIN PRESERVATION ON TISSUE WEIGHTS OF BIRDS. Patrick F. Scanlon, Alan G. Clark and John Whelan. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Tissues from organs of 40 Japanese quail, *Coturnix coturnix japonica*, and 11 mallards, *Anas platyrhynchos*, were weighed and preserved in 10% formaldehyde for 138 days (quail) or 27 days (mallards). The tissues were then re-weighed and differences noted. Changes in the following quail tissues were observed (number of observations in parentheses): heart (39) -3.63%; liver (36) -15.22%; intestine (3) +3.92%; glandular stomach (39) +0.57%; and gizzard (39) +1.01%. Changes in the following mallard tissues were noted (number of observations in parentheses): heart (11) -24.97%; liver (10) -22.35%; kidney (11) -27.77%; spleen (11) -24.97%; glandular stomach (11) -11.67%; intestine (11) -14.87%; and gizzard (11) -8.29%. The changes resulting from formalin preservation seemed to vary with tissue studied and possibly with species and length of preservation.

ASPECTS OF MOURNING DOVE NESTING IN VIRGINIA. Patrick F. Scanlon, Janet E. Clarke, Catherine J. Flick, and W. Hassel Taylor. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Portions of the VPI & SU campus were searched weekly for mourning dove nests during the 1979 and 1980 breeding seasons. Sixty-three nests were found in 10 species of trees of which all but one species were conifers. Nesting commenced as early as March and nests were not initiated later than August. Twenty-seven of 47 nests located in 1979 successfully produced young. Mean (± S.E.) number of eggs laid was 1.88 ± 0.05, of which 1.81 ± 0.07 were hatched and 1.67 ± 0.09 were fledged. In 1980 6 of 16 nests were successful with 1.86 ± 0.14 eggs laid, 1.80 ± 0.2 eggs hatched and 1.6 ± 0.24 young fledged. Causes of nest failure which could be assigned were weather (wind), human disturbance, and death of parents. Many of the nests were located in non-native tree species. Reuse of nests was observed in 16 of 63 instances. (Supported by P/R Project No. W-40-R-27).

LEAD CONCENTRATIONS OF MALLARD DUCK LIVERS INGESTING LEAD PELLETS AND/OR SHOT BY LEAD PELLETS. Patrick F. Scanlon, Timothy J. Dietrick, and J. Thomas Jones. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Forty mallard ducks, *Anas platyrhynchos* , were randomly assigned within the experiment. Half were dosed orally with 4 number 4 lead pellets; the other half was left untreated. After 4 days all 40 were sacrificed. Half of each of the above groups were sacrificed by decapitation, the remaining individuals were shot with No. 4 lead pellets from a 12 gauge shot gun from a range of 20 m. Livers were dissected from each individual. Livers from each shot duck were examined for penetration by lead pellets. Analyses of lead concentration of livers of all ducks were conducted by Atomic Absorption Spectrophotometry. All ducks not ingesting lead shot had lead concentrations below the limit of detection (0.2 µg/kg dry weight) whether shot or decapitated. Seven of the shot individuals had evidence of pellets penetrating their livers. Mean (± S.E.) lead concentrations of livers of ducks ingesting lead shot were 187.6 (± 49.2) µg/g for decapitated ducks and 105.2 (± 17.6) µg/g for shot ducks. It was concluded that shooting with lead pellets did not increase lead concentrations of livers of the shot subjects, a finding important relevant to the value of hunter killed animals as sources for monitoring environmental contamination.

FORAGE DIGESTIBILITY FOR WHITE-TAILED DEER, *Odocoileus virginianus*, IN LOBLOLLY PINE, *Pinus taeda*, PLANTATIONS DURING THE SPRING AND FALL SEASONS. John J. Scanlon, T. L. Sharik and R. L. Kirkpatrick. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.

Digestible energy was estimated for 3 forage classes (leaves of deciduous woody plants, forbs, and grasses) using a Van Soest chemical analysis. The predicted digestibility of forbs and leaves of woody plants increased slightly through the spring season to a maximum level (80%) in June, and declined in early fall to a low of 69% in October. A secondary increase occurred in November (74% digestible), when available forage was limited to a few succulent, late season species. Increasing digestibility was associated with higher ratios of cell solubles to lignin for both forage classes. The digestibility of grasses increased steadily through the spring season to a maximum level (87%) in June, and declined throughout the fall season to a low of 67% in November. Grasses maintained a high proportion of cell wall contents (60%) in all months, and an increase in the ratio of cellulose and hemicellulose to lignin in the cell walls resulted in higher digestibility for grasses. A large and important component of total digestible energy available to deer is supplied by herbaceous vegetation. Management efforts could be directed toward increasing this production by removing hardwood sprouts from stands in the pre-crown closure stage (up to 12 years old).

THE PALEOECOLOGICAL SIGNIFICANCE OF BENTHIC ALGAL MATS IN ANTARCTIC LAKES. G.M. Simmons, Jr., B.C. Parker, R.A. Wharton, Jr.*, F.G. Love,* and K.G. Seaburg.* Dept. of Biology, V.P.I.&S.U., Blacksburg, VA 24061

The dry valley lakes of southern Victoria Land, Antarctica contain algal mats dominated by blue-green algae and diatoms. Higher forms of life such as crustacea, mollusca, insects and fish are absent. The lakes are permanently covered by 3.0-5.5 m of ice which absorbs 80-99% of incident radiation. The benthic algal mats existing beneath the ice-cover structurally are similar to those existing during the Precambrian Period 600 million years ago. The ecological nature of these lakes suggests modern analogs of Precambrian ecosystems. Algal laminated structures have been observed in the lakes studied and represent one of the few cases of freshwater stromatolite formation. The benthic habitat of these lakes may resemble ancient deep-water habitats because of light extinction, low temperature, and absence of internal currents due to ice-cover. The variability of limnological properties between the lakes provides a basis for interpreting ancient environmental factors governing ancient stromatolite form and structure.

INDIRECT IMMUNOFLUORESCENCE MICROSCOPY AS AN AID TO FISH TAXONOMY. E. N. Sismour, Steven B. Ackerman and R. S. Birdsong, Dept. of Biol. Sci., ODU, Norfolk, VA 23508

Black drum (Pogonias chromis) and grey trout (Cynoscion regalis) are members of Sciaenidae and spawn concurrently in the Chesapeake Bay. Studies of the early life history of these and other fishes are often hampered by an inability to identify eggs and larvae. Investigations were conducted to determine the feasibility of employing immunologic techniques for identification purposes. Antisera to black drum and grey trout eggs were generated in rats by immunization with homogenates of unfertilized eggs. Immunological specificity was observed when anti-black drum antiserum was tested against fertilized black drum eggs by indirect immunofluorescence. However, cross-reactivities were noted when these antisera were tested against unfertilized eggs of both species. Results indicated that specific antibodies can be developed which may be used in conjunction with meristic features in taxonomic evaluation of eggs and larvae.

SEX PHEROMONE ACTIVITY IN IXODID TICKS: A REVIEW. D. E. Sonenshine and P. J. Homsher, Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508.

Pheromones constitute an important component of animal communication systems. In the hard ticks (Ixodidae), a general sex pheromone, 2,6-dichlorophenol, attracts sexually active (SA) males to feeding females for mating. This compound excites feeding males, stimulating them to detach. It also assists the SA males in locating the female and identifying it as a suitable sex partner. This pheromone, found only in mature adult females, is released only during feeding. The pheromone is stored, apparently, in lipid secretory droplets in a pair of lobular glands below the dorsal cuticle. Secretion of pheromone occurs when the secretory droplets pass through the elaborate system of ducts and pores of the fovea dorsalis and on to the external surface. Individual pores can be opened or closed, providing a mechanism for regulating secretion. The possible existence of other pheromones or repellents which may be used to minimize interspecific matings is being explored. (Aided by NIH grant AI10,986).

A SURVEY OF THE HELMINTH PARASITES OF RATS, RATTUS NORVEGICUS, FROM MAYMONT PARK, RICHMOND, VIRGINIA. G.A. Spatafora* and T.R. Platt. Dept. of Biology, Univ. of Richmond, Richmond, Va. 23173.

Twenty-one male rats were examined for the presence of helminth parasites. Fifteen rats (11 juveniles, 4 adults) were collected in the fall of 1980 and six animals (2 juveniles, 4 adults) were collected in the spring of 1981. Two species of nematodes, Heterakis spumosa and Nippostrongylus brasiliensis, and the cestode, Hymenolepis nana, were found. Each species demonstrated a high degree of site specificity within the intestine.

Eighty percent of rats collected in the fall were infected with N. brasiliensis and H. spumosa, respectively. Mean densities were 102.3 and 35.9, for these species,respectively. Sixty seven percent of the rats harbored both species concurrently. Heterakis spumosa and Hymenolepis nana were found in 83 and 33% , respectively, of rats collected in the spring. Mean density was 60 for H. spumosa and 36 for H. nana.

Trichinella spiralis and Capillaria hepatica were not found.

SMALL MAMMALS OF THE DISMAL SWAMP. J. F. Stankavich*, and R. K. Rose. Dept. of Biol. Sci., ODU, Norfolk, VA 23508

Small mammals were studied on two grids in clearings of the Dismal Swamp of Virginia. Using Fitch live traps, eight species were captured in vegetation dominated by cane (Arundinaria gigantea), softstem rush (Juncus effusus), sedges and grasses. These results were further compared to recent studies of Dismal Swamp small mammals in similar type vegetation and forested habitats.

THYROID FUNCTION IN JAPANESE QUAIL CHICKS (Coturnix coturnix japonica) F. W. Stanton and F. M. A. McNabb, Department of Biology, VPI & SU, Blacksburg, Va. 24061

The objective of this study was to describe thyroid activity during the post-hatching period when quail chicks are developing thermoregulatory control. It was postulated that thyroid activity would be positively correlated with the intensity of metabolic heat production. Previous studies have shown that an increase in insulation (plumage), and decreases in cutaneous evaporative water losses and surface: volume ratios contribute to the increased heat resistance to heat loss during the first 3 weeks after hatching. Thus, metabolic demands for endogenous heat production are decreased during this time.

Thyroid activity, as indicated by both thyroidal ^{125}I uptake and plasma thyroxine concentrations, is high in the early post-hatching period when metabolic demands are high (hatching activity and initial thermoregulatory reponses). In 3-6 day chicks, while yolk reabsorption is occurring and chicks are not gaining metabolically active tissue, thyroid activity is low. In 8-21 day chicks thyroid activity increases but at a slower rate than the increases in thyroid and body weights (which parallel each other). Thus during this period thyroid activity, on a weight-specific basis decreases slightly, concurrent with the lessened metabolic demands. Thyroid activity in 21 day chicks is slightly higher than that of adults.

THYROTROPIN STIMULATION IN EMBRYONIC JAPANESE QUAIL (Coturnix coturnix japonica). F. W. Stanton, F. M. A. McNabb, and R. T. Weirich.* Dept. of Biology, VPI & SU, Blacksburg, VA 24061.

The development of embryonic thyroid function in quail suggests two phases of stimulation by thyroid stimulating hormone (TSH) from the pituitary. From days 10-15 of incubation thyroid activity increases at a rate moderately greater than the rate of thyroidal growth. During the perinatal period there is a burst of very high thyroid activity and marked changes in the hormone ratios suggestive of increased hormone turnover, utilization or degradation.

This study investigated thyroidal responsiveness to TSH during the latter half of incubation. Preliminary studies indicated that embryonic thyroids were unresponsive to single doses of exogenous TSH (bovine, ovine or avian), as indicated by traditional bioassay techniques using ^{125}I or ^{32}P uptake to indicate thyroid activity. Endogenous TSH release, stimulated by negative feedback using thiourea, produced a measurable thyroid response as indicated by thyroidal hypertrophy or thyroidal ^{32}P uptake. The decrease in plasma thyroxine concentrations that elicits this negative feedback response is marginally detectable by the RIA method used. The increases in thyroid functional capacity, as indicated by ^{32}P uptake, appear to be in simple proportion to the degree of thyroidal hypertrophy. In contrast to other species, thyroidal ^{125}I uptakes do not increase with TSH stimulation. Maturation of the feedback system has occurred by days 10-11 of the 16.5 day incubation period.

BREEDING BIRDS OF HARDWOOD LEAVE STRIPS IN VIRGINIA'S CENTRAL PIEDMONT. J. F. Tassone* and T. L. Sharik. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.
Twelve hardwood leave strips in various aged loblolly pine stands in Virginia's central Piedmont were studied to determine distributions of breeding birds in relation to features of vegetation and landscape, and to evaluate the potential of leave strips as breeding habitat. Occurrence of 38 probable breeding species was related to 14 measured variables through the use of ordination on principle components and graphical techniques. A variety of variables relate to different species distributions. Buffer strip width, stream size, foliage density in the understory, and overstory stem densities in various diameter classes are suggested as key factors influencing distributions of several forest breeding species. Properly managed leave strips would be of great potential value as breeding bird habitat in intensively managed pine plantations.

BREEDING BIRDS OF TWO ATLANTIC WHITE CEDAR STANDS (CHAMAECYPARIS THYOIDES) IN THE GREAT DISMAL SWAMP. K. A. Terwilliger*, Wildlife Biologist, Dismal Swamp N.W.R., Suffolk, Va. 23434
Breeding birds were censused in two Atlantic White Cedar stands in order to describe the avifauna of this vanishing community and provide a data base for future management and comparison. The two stands, representing different ages and vegetation structures, supported different densities and diversities of bird life. The older, structurally more complex stand was richer in species but poorer in density than the younger stand. Spatial distribution of the birds in the stands was analyzed in terms of vertical height diversity and niche breadths. Vertical distribution differed between stands and cluster analysis grouped avifauna into distinct height associations. Cedar stand census results were compared to those of the predominant swamp community (maple/gum) and were found to be less diverse but more dense. Avifauna of the older cedar stand was found to be more similar (66.8%) to the maple/gum site than to the younger cedar site (52.8%). Insectivores, as in most coniferous habitats, dominated the cedar avifauna, as Parulidae outnumbered all other families combined.

TEMPORAL RELATIONSHIPS BETWEEN CALCIUM, CHITIN, AND PROTEIN IN THE CUTICLE OF POSTMOLT BLUE CRAB, CALLINECTES SAPIDUS. David A. Vigh and James E. Dendinger. Dept. of Biology, James Madison Univ., Harrisonburg, Va. 22807

The temporal relationships of the deposition of calcium, magnesium, chitin and protein were studied in the postmolt cuticle of the blue crab, Callinectes sapidus.
Detectable calcification began some time between 10 and 24 hrs postmolt and continued through at least 68 hrs postmolt, at which time the calcium was 6.4 mg/cm^2 cuticle, or 22.2% of the sample dry weight (SDW).
Magnesium deposition was first detected approximately 90 min postmolt, reached a maximum value of 0.52 mg/cm^2 cuticle, (4.2% SDW) and declined to 0.34 mg/cm^2 cuticle (1.1 SDW).
The relative amount and rate of chitin deposition was less than that of calcium. By 69 hrs postmolt, chitin was 3.31 mg/cm^2 (11% SDW).
The average concentrations of sclerotin and arthropodin were 0.79 mg/cm^2 and 0.92 mg/cm^2 cuticle, respectively, and no new deposits of these proteins were detected up to 69 hrs postmolt. In contrast, HCl-soluble protein increased to 3.2 mg/cm^2 (10.7 SDW) during the same time interval.

Nuclear Thyroid Hormone Receptors in Quail Hepatocytes Richard T. Weirich and F. M. Anne McNabb, Dept. of Biology, VPI & SU, Blacksburg, VA 24061
Avian nuclear thyroid hormone receptors were characterized using liver, a thyroid hormone-responsive tissue, from adult male Japanese quail. Since T_3 binding to nuclear receptors appears to initiate thyroid hormone action in mammals, T_3 receptors were the primary focus of this study.
Fresh liver nuclei were suspended in an augmented Tris-HCl buffer. Receptor binding was maximal at 20° from 60-120 min; pH optimum was 7.4. Specificity for T_3 was established; nonspecific binding was <15% of total.
Binding reversibility was shown by displacing radioactive hormone with unlabelled T_3. Scatchard analysis indicated equilibrium dissociation constants of 1.31 x 10^{-9}M (range 0.55 - 2.80 x 10^{-9}M; N = 6 experiments) for a single class of receptors. Binding capacities were within the range for mammalian liver tissue. Competition studies indicated highest affinity of the receptor was for L-T_3, closely followed by D-T_3, then by L-T_4, D-T_4, and L-T_2. MIT and DIT did not compete with L-T_3 for receptor binding.
The nuclear T_3 receptors in quail liver have characteristics similar to those in mammals. However, the data suggests L-T_4 has greater receptor affinity in birds than in mammals. (Aided by a Biomedical Research Support Grant, VPI & SU)

FREQUENCY OF *Gnathostoma miyazakii*, IN KIDNEYS OF RIVER OTTERS IN VIRGINIA. John Whelan, Karen L. Anderson and Patrick F. Scanlon. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061.
During the winters of 1979-80 and 1980-81 river otter, *Lutra canadensis*, carcasses were collected in Virginia and 358 kidney pairs (201 in 1979-80; 157 in 1980-81) were examined for infestation with *Gnathostoma miyazakii* (Anderson 1964). *G. miyazakii* was recovered from the tubules of the kidneys, the anterior ends in some instances being in the connective tissue. The maximum number recovered from a kidney was 7; 13 being the greatest number from a pair of kidneys. Of all otters examined, 53.35% were infested (56.72% in 1979-80; 49.04% in 1980-81). In the 1979-80 season a higher percentage of males was infested, while in 1980-81 an equal number of both sexes were infested. The percentage of kidneys infested in each class was: (1979-80) 0-1 yrs., 54.1%; 1-2 yrs., 61.7%; 2-3 yrs., 70.6%; 3-4 yrs. 57.1%; 4-5 yrs., 42.9%; (1980-81) 0-1 yrs., 48.9%; 1-2 yrs., 61.1%; 2-3 yrs., 38.9%; 3-4 yrs., 53.3%; 4-5 yrs., 50.0%; 5-6 yrs., 50.0%.

THE EFFECTS OF CRYOPRESERVATION ON THE HUMAN LYMPHOCYTE'S CAPACITY TO PRODUCE LEUKOCYTE INHIBITORY FACTOR (LIF). G. K. Whitaker* and M. F. Pinkston, Dept. of Biochemistry, Mary Baldwin College, Staunton, VA 24401.
LIF inhibits the migration of normal polymorphonuclear leukocytes (PMNs) incubated in its presence. This factor is characteristically produced in cases of delayed-type hypersensitivity, both *in vivo* and *in vitro*, by sensitized lymphocytes in the presence of the specific sensitizing agent. Its production can also be stimulated non-specifically by very low concentrations of mitogens.
Since fresh blood samples of sensitive persons are difficult to procure on a continuing basis, a means of preserving lymphocyte samples to permit testing of different possible sensitizing agents over a period of time is needed. Cryopreservation of lymphocytes in Liquid N_2 has been shown to allow retention of most functions. We have sought to determine if, after cryopreservation in a 2-stage crash-freezing process, lymphocytes of normal and sensitive persons can maintain their viability and capacity to produce LIF.
Production of LIF after non-specific stimulation with phytohemagglutinin has been determined by the Leukocyte Migration Inhibition Assay, using the agarose microdroplet method. When incubated in supernatant from unstimulated cells, normal PMNs migrate beyond the limits of the agarose droplet; when incubated in supernatant containing LIF, they remain within its bounds.
Results to date are promising; we are not yet fully successful in maintaining viability after cryopreservation.

THE TRINOMEN AND THE ENDANGERED SPECIES ACT. Raymond R. White, Dept. of Biology, Old Dominion University, Norfolk, Va. 23508

The subspecies level of taxonomy remains in general use. It is sanctioned but undefined by the International Code of Zoological Nomenclature. Unfortunately the definitions in use vary greatly. Some taxonomists would assign subspecific rank to two populations if 75% of either population can be told from 90% of the other on the basis of at least one character. Some would do so only if the populations are partly isolated in terms of gene flow, as well. Others would require that several characters be different. The Endangered Species Act allows protection of subspecies, but does not define the term.

What I propose is that only populations that differ in five or more characters and are partially isolated with respect to gene flow should be recognized as subspecies. Thus, only a well differentiated population that has its own unique evolutionary potential can be recognized at the subspecific level and protected by the Endangered Species Act.

BLASTOGENIC RESPONSES OF POOLED AND UNPOOLED LEUCOCYTES, Trenia Winbush, and Evelyn Jemison,* Cytogenetics Laboratory, Department of Life Sciences, Virginia State University, Petersburg, Virginia 23803

Blastogenic responses of pooled and unpooled leucocyte cells from peripheral blood fractions are assayed after exposure to phytohemagluttin and varied concentrations of fetal calf serum. Three different culture media are used for each experiment: (1) TC 199, medium + 8% FCS (2) TC 199 medium + 4% FCS + 4% donor plasma and (3) TC 199 medium + 2% FCS + 6% donor plasma. Each vial contains 9.2 ml of TC 199 medium, .5 ml of PHA, and .2 ml of antibiotics. Hemacytometer counts are taken at 24 hour intervals for three (3) consecutive days. Preliminary results of this experiment, when using pooled leucocytes supplemented with two percent fetal calf serum (FCS) and six percent donor plasma indicated optimum growth of leucocyte cells; eight percent FCS without donor plasma and four percent donor plasma effectively maintained leucocyte cultures for 72 hours. (Supported by NIH/MBS grant S06-RR-08090-09)

KEPONE LEVELS OF SELECTED TERRESTRIAL ANIMAL SPECIES FROM THE JAMESTOWN ISLAND AREA. Cynthia L. Willard-Mack* and C. Richard Terman, Biology Dept., College of William and Mary, Williamsburg, Va. 23185.

Comparisons were made of the Kepone levels in the livers of a minimum of 5 individuals of several species of vertebrates from Jamestown Island (J.I.) and the Ecological Study Area (control) of the College of William and Mary. The species sampled and the Kepone levels ($\bar{x}$ ppm) of the J.I. animals were: Colubridae and Viperidae snakes (4.09+1.650), Blarina (.96+.380), Didelphis (1.21+.574), Procyon (.42+.170), Peromyscus leucopus (.31+.079), Sciurus (.23+.075), Terrapene (.02+.007), Sylvilagus (.01+.004), and Odocoileus (non-detectable [n.d.]). With the exception of the last three, the mean Kepone levels were significantly higher than in the control animals.

The whole bodies of several individuals of five invertebrate groups were pooled and the samples analyzed yielding the following means: Lumbricus (n.d.), Acrididae (n.d.), Gryllidae (n.d.), Silpha (.27), and Microthena (.40).

The mean Kepone load of the J.I. vertebrates increased in the following order: granivores (.27+.054), omnivores (.54+.201), and carnivores (2.78+1.050). Variability also increased with the mean Kepone content suggesting a non-uniform exposure at least at the higher levels of the food chain. Similar trends were observed in the control animals to a lesser degree. These data confirm that Kepone contamination of the terrestrial ecosystem is extensive.

SOCIAL BEHAVIOR, GROWTH CHARACTERISTICS, AND REPRODUCTIVE ORGAN WEIGHTS OF WHITE-FOOTED MOUSE (PEROMYSCUS LEUCOPUS NOVEBORANCENSIS) POPULATIONS IN THE LABORATORY. Charles C. Wolfe and C. Richard Terman, Dept. of Biology, Coll of William and Mary, Williamsburg VA 23185.

Four populations of white-footed mice were founded by placing four bixenual pairs in each of four 20 sq ft circular enclosures containing eight next boxes. Food and water were supplied in surplus and the populations were observed 1/2 hour 2-3 times a week until growth ceased (no young surviving during a period of 150 days). All animals were checked on a bi-weekly basis for reproductive condition. The populations were sacrificed after growth had ceased and selected organs of individual animals were weighed. Bisexual pairs were placed in galvanized steel cans with a diameter of 48.26 cm to act as controls. Two next boxes were provided and all other environmental conditions were similar to the above except the young were removed at weaning.

Each population was characterized by a high level of aggressiveness resulting in the death of 3 of the 4 founding males. Growth occurred in 3 of the 4 populations after this period. The populations attained variable numerical levels at asymptote with the control of growth being achieved either by cessation of reproduction or failure of young to survive.

Aggressiveness appears to be inversely related to litter survival with high survival of young occurring when the level of aggression is low. Analysis of the reproductive organs and adrenal gland weights revealed no significant differences between population and control animals.

Botany

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
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SUCCESS OF PINES IN THE VARC EXPERIMENTAL PINUS TAEDA FOREST. Jennie Alvernaz*, and Barry Ensley*, Dept. of Biology, Christopher Newport College, Newport News, Va. 23606

Growth of a 10-year old loblolly pine (Pinus taeda L.) stand was observed in 24 (6- x 24- m) quadrats on a Bladen loam in the Coastal Plain of Virginia. The study was intended as a comparison to a similar study conducted in 1979 on a nearby tract. Variables between the two studies included soil type and topographical differences. It was established that the trees in the 1979 study had significantly lower densities and proportionately fewer trees 16 feet and greater in height than those in the current study. These differences were probably due to water levels and topography changes caused in part by logging practices used when clearing the area for replanting.

RELATIONSHIP OF VEGETATION TO HYDROLOGY AND SOILS IN THE GREAT DISMAL SWAMP, VIRGINIA AND NORTH CAROLINA. Virginia Carter*, P. T. Gammon*, U.S.G.S., Reston, VA 22092, and M. K. Garrett*, U.S.F.W.S., Suffolk, VA 23434

The distribution of vegetation within the Great Dismal Swamp and on the upland-to-wetland transition zone in its western boundary is related to soil type, ground-water level, and duration of surface inundation. Changes in vegetation, water table, surface flooding, soil type, soil moisture, and soil and ground-water oxygen content are being measured in the transition zone. A preliminary quantitative analysis of three vegetation layers in the transition zone using a line-intercept method suggests that species distribution is a function of plant tolerances to the complex interaction of all the components being measured.

Preliminary data from observation wells and estimates of surface flooding in five vegetation communities on organic soils within the swamp, suggest a relationship between hydrology and community composition. Although water levels for various sites are similar during droughts, maple-gum-cypress and loblolly pine types have higher water tables than the evergreen shrub, Atlantic white cedar; and mixed hardwood sites during the growing season.

PHYTOPLANKTON IN TEMPORARY SURFACE WATERS IN A DISMAL SWAMP CYPRESS STAND. J. A. Atchue, III*, H. G. Marshall, and F. P. Day. Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

During the winter and early spring standing water can be found in areas of the Great Dismal Swamp and is often populated by phytoplankton. The phytoplankton populations in a Cypress community were sampled on a twice monthly schedule from mid-January 1980 until the water disappeared in late April. A succession pattern was noted through the collection period among the 14 genera and 30 species identified, with total cell numbers ranging from 4200 cells/ml (14 Jan. 1980) to 17000 cells/ml (10 Mar. 1980). The dominant forms included the pennate diatoms, Pinnularia spp. and Eunotia spp. and a cyanophyte, Oscillatoria submembranacea. Both Pinnularia abuajensis and O. submembranacea were found throughout the sampling period. Eunotia curvata and E. sudetica were also common in most of the samples. Other less common diatoms included Tabellaria fenestrata, Cymbella sp. and Synedra sp. The Chlorophyta were represented by Microspora pachyderma, M. tumidula and Oedogonium sp. Two chrysophycean species of Mallomonas became important after 10 March 1980. These and other apparent successional patterns were discussed with the aid of cluster analysis.

PATTERNS OF SECONDARY SUCCESSION IN MONTANE HABITATS. Dean Cocking. Department of Biology, James Madison Univ., Harrisonburg, VA. 22807

Shenandoah National Park was established in 1934 with the simultaneous abandonment of a mosaic of vegetation at various different stages of successional development. The heterogeneity of the montane environment and the existence of a relatively detailed vegetation map which was prepared by L. Y. Berg and R. B. Moore in the late 1930's, has made this segment of the Blue Ridge Mountains amenable to the study of the process of succession. Several James Madison University graduate students in biology including E. Baxter, D. Stoltzfus, M. Lipford and R. Owermohle have been involved in a comprehensive study of plant community composition in "meadowlands", 40-yr old fields, and "late successional" and "mature all-age" forest stands which are currently located at different elevation and slope combinations within the park boundaries.

A quantitative data base is being developed which details the community development through Robinia pseudoacacia and Fraxinus americana successional forests toward mature oak-hickory forests on the southeast facing slopes and forests with northern hardwood and hemlock components on the cooler northwest slopes at higher elevations. Changes in species composition and successional rates which are related to complex environmental gradients are being documented.

AN EVALUATION OF DISJUNCTNESS IN THE DISTRIBUTION OF RIVER BIRCH (BETULA NIGRA L.). B. F. Coyle*, T. L. Sharik, and P. P. Feret. Department of Forestry, VPI & SU, Blacksburg, VA 24061

As part of a study of morphological variation in the species Betula nigra L., river birch, an attempt was made to verify the existence of outlying, disjunct areas of occurrence which appear on various range maps. A review of these range maps indicated 18 separate marginal areas which are disjunct from the continuous range of the species. Of these disjunct areas, only four were verified as natural populations of river birch. The occurrence of the species in the remaining areas was apparently reported on the basis of horticultural plantings, misidentification, or small populations which have since perished. It is suggested that intensive investigations of other widespread tree species in North America are needed to verify the occurrence of presumed disjunct populations.

ISOLATION AND PARTIAL CHARACTERIZATION OF A LECTIN FROM THE SEEDS OF CERCIS CANADENSIS (EASTERN REDBUD). Muriel Dahlgard, Seniz Bolat*, and Kari Moldenhauer*, Dept. of Chemistry, Randolph-Macon Woman's College, Lynchburg, VA, 24503.

Seeds of Cercis canadensis were homogenized in phosphate buffered saline (pH 7.2) and the protein material was precipitated from the filtered extract by saturation with ammonium sulfate, followed by dialysis. Separation of the crude protein mixture by gel chromatography on a 40 x 0.9 cm. column of Sephacryl S-200 Superfine (Pharmacia), monitored at 280 nm in the U.V. region, resulted in the isolation of a lectin which showed nonspecific hemagglutinating activity against types A, B and O red blood cells.

To determine the sugar specificity of this lectin, hemagglutination was studied in the presence of D- glucose, D-galactose, D-mannose, D-glucosamine, D-galactosamine, D-mannosamine, N-acetyl-D-glucosamine, N-acetyl-D-mannosamine, N-acetyl-D-galactosamine, L-fucose and sialic acid. Only N-acetyl-D-glucosamine was found to be effective in inhibiting hemagglutination by this lectin, indicating that the lectin from Cercis canadensis appears to be similar to the lectin found in wheat germ.

STUDIES OF ECOSYSTEM STRUCTURE AND FUNCTION IN THE GREAT DISMAL SWAMP. Frank P. Day, Jr. and Gerald F. Levy. Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508

Research at the plant community and ecosystem level of organization has been conducted in the Dismal Swamp in six primary categories. (1) Vegetational dynamics – The autecology of particular species (eg. Chamaecyparis thyoides) and successional patterns are being examined. (2) Ecology of red heart disease – Conditions affecting the dynamics of Fomes pini infection are being studied. (3) Community structure – Most of the ecosystem research is being conducted in four distinct communities which differ in species composition and extent of flooding. A major goal has been to determine the affects of hydroperiod on system structure and function, eg. the flooded sites have greater basal area and biomass. (4) Primary productivity – The flooded sites also exhibit higher leaf production rates and stem diameter growth. (5) Decomposition – A major effort is in progress to fully evaluate decay processes in a swamp environment. Generally, decay is faster on the flooded sites. (6) Nutrient dynamics – Another major goal is to characterize nutrient recycling in a seasonally inundated swamp ecosystem.

EFFECTS OF LIGHT ON THE POLYPHENOLOXIDASES OF THE TETRASPORE ASCOMYCETE PODOSPORA ANSERINA NIESSL. Melanie A. Harper*, sponsored by James E. Perham. Randolph-Macon Woman's Col., Lynchburg, VA 24503

In vivo studies of sexuality in Podospora anserina Niessl have shown that light stimulates the production of perithecia. The phenoloxidases of Podospora have been implicated in the development of sexual structures. Tyrosinase and laccase activity levels were compared from cultures grown in the light and cultures grown in the dark. In spectrophotometric tests involving dopachrome accumulation, cultures grown in the dark were found to have a higher tyrosinase activity than cultures grown in the light. With the exception of 48-hour cultures, the activity of laccase was found to be greater in cultures grown in the light. This study shows a direct relationship between both fruiting body formation and light and polyphenoloxidase activities and light.

EFFECTS OF EXCESSIVE COPPER LEVELS ON *Skeletonema costatum* (Greville) Cleve. Susanne S. Jackman* and H. G. Marshall. Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

Copper levels and dominant phytoplankton composition were examined from six sites in Kings Creek on Virginia's eastern shore from March to August 1980. Copper levels were determined by an APDC-MIBK extraction procedure and ranged from 0.003 mg/l to 0.020 mg/l. Diatoms were dominant with *Skeletonema costatum* as the major species in late summer.

Subsequent laboratory studies involved 96 hour experiments using *S. costatum* (clone Skel) grown in enriched natural sea water. The water was collected from Kings Creek and enriched according to Guillard's (1975) F/2 media levels. Cupric sulfate was added to the experimental culture media from stock solutions yielding final copper concentrations of 11.7 µM, 13.7 µM, 15.7 µM, 17.7 µM and 31.5 µM. After 96 hours copper exposed *S. costatum* cells were harvested by filtration, digested and analyzed for cellular copper content. The copper content of the control cells was below detection limits, while cells exposed to excessive copper levels ranged from 576 µgCu·g^{-1} dry weight to 8929 µgCu·g^{-1} dry weight. Culture media in which cells were grown and in which no cells were grown were analyzed for ionic and chelated copper levels using Chelex-100 in ion-exchange columns.

GEOGRAPHIC ANALYSIS OF THE FOREST VEGETATION OF VIRGINIA. W.C. Johnson*, T.L. Sharik, and P.W. Reily, Dept. of Biol. and Forestry, Va. Polytech. Inst., Blacksburg, VA 24061.

The relationships between tree distribution patterns and environmental variables were examined using factor analysis. Distribution patterns of 44 tree species were determined from 4,400 sample plots of the USDA-Forest Service. Environmental parameters included temperature, precipitation, elevation and major soil groups. Five factors accounted for 53.4% of the total variance. Variables with the strongest correlations to factor 1 included Quercus prinus (+0.85), Liquidambar styraciflua (-0.85), elevation (+0.89) and mean annual temperature (-0.96). This factor represents the strong elevation and temperature gradient across the state and the species primarily restricted to either the Appalachian Mountains or the Coastal Plain. The second factor included species with maximum abundance in the Piedmont [e.g., Juniperus virginiana (+0.65), Pinus virginiana (+0.67)]. The three remaining factors were related to topo-edaphic conditions in the Appalachian Mountains (factor 3, Pinus rigida), old-field species in the northern Piedmont (factor 4, Juglans nigra) and species with maxima at intermediate montane elevations (factor 5, Pinus strobus). The results emphasize the primary importance of elevation (temperature) in affecting the macrodistribution of Virginia trees, with secondary patterns related to soils, local topography and land use.

FALL PHYTOPLANKTON DISTRIBUTION IN NORTHEASTERN WATERS OF THE CONTINENTAL SHELF. L. A. Kalenak* and H. G. Marshall. Depts. of Biological Sciences and Oceanography, Old Dominion University, Norfolk, Va. 23508

Surface samples were collected from 39 stations off the eastern coast of the United States in September 1980. Samples were analyzed using a modified Utermohl method. A total of 162 species were identified consisting of diatoms (84 species), dinoflagellates (53 species), coccolithophores (11 species), and representatives from six other classes. Ubiquitous species were *Skeletonema costatum*, *Leptocylindrus danicus*, and *Nitzschia pungens*. Dominant diatoms included *Rhizosolenia* spp., *Chaetoceros* spp., *Eucampia zoodiacus*, and *Asterionella glacialis*. Characteristic of the near shore were dinoflagellates and silicoflagellates. These included *Prorocentrum micans*, *Scrippsiella trichoidea*, *Distephanus speculum*, and *Ebria tripartita*. Far shore waters had a greater coccolithophore composition, with *Emiliania huxleyi*, *Syracosphaera pulchra*, and *Rhabdosphaera claviger* common. In addition, an unidentified ultraplankton component was common in the samples. Average cell numbers per liter decreased from 1,400,000 cells/l at near shore stations to 157,000 cells/l at far shore stations. However, there was a distinct population increase noted along the margin of the continental shelf.

This study was supported in part by the NOAA Northeast Monitoring Program.

A QUANTITATIVE STUDY OF HARDWOOD STANDS IN BUCKS COUNTY, PA. John M. Kasmer* and Paul R. Kasmer, Jr.*, Dept. of Biology, Coll. of William and Mary, Williamsburg VA 23185.

A quantitative study was made of forty relatively old, undisturbed hardwood stands in Bucks Co., PA north of Philadelphia in the Piedmont lowland. Sampling was by the Bitterlich method and the stands were arranged in a Bray-Curtis ordination. Dominant species in most stands were one of Fagus grandifolia, Liriodendron tulipifera, Quercus alba, Acer saccharum, A. rubrum and Q. velutina. Q. rubra was widespread but was never the leading dominant. The x-y and y-z axes of the ordination clearly separated ten of the twelve important species. Q. alba and A. rubrum was found together, as were L. tulipifera and Cornus florida. In contrast to previous work, Tusga canadensis occurred with A. saccarum and in good, less acid soild while F. grandifolia was segregated from A. saccharum and occurred in poorer, more acid soils. In general, the results indicate that Bucks Co. is part of Braun's former oak-chestnut region but with greater representation of mesic species, and is similar to stands previously studied in DE and S.E. PA. The importance of A. saccarum, A. rubrum, F. grandifolia and Fraxinus americana is consistent with proposed future composition of Piedmont forests in N.J.

DIRECT ENUMERATION OF HIGHER FUNGI IN SEAFOAM. Paul W. Kirk, Jr., Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508.

A flotation method was devised for direct enumeration of fungi in seafoam, beach sand and wrack, the water column and surface layer (wire screen samples) of inshore waters. Samples were taken in Virginia Beach at high and low tides, during calms and on-shore winds, throughout the fall of 1980.

Samples were decanted to remove sand, formalinized, and settled for 1 week before supernatant was siphoned off. Sediments were washed centrifugally to remove sand, and their concentration adjusted to about 100mg dry weight per ml of 5% formalin. Samples (0.5ml) were centrifuged in several 2.5ml washes of 70% (w/v) (NaPO$_3$)$_{13}$ to free spores from clay particles. Suspensions were diluted in 25ml perspex settling chambers, and after 12 hours the settled spores and hyphae were counted with an inverted microscope using random fields as needed.

The method was far more sensitive and precise than others in use, and broadly applicable to marine mycology. Virginia was established to be the northern limit of *Varicosporina ramulosa*. Over 32 fungal taxa were present in amounts as high as 2 million propagules/g of sand- and salt-free foam. Many spores of *Corollospora* spp. in wrack were shown not to originate there, but in sublittoral sands from which they are transported in seafoam.

A MYCOSTATIC PRINCIPLE IN SEAWATER. Paul W. Kirk, Jr., Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508.

A mycostatic principle resembling that in soils was identified in waters of various salinities from Virginia Beach and the Elizabeth River estuary. Spores of six terrestrial species in Aspergillus, Penicillium, Fusarium and Trichoderma, and those of the presumed facultative marine fungus, Dendryphiella salina, showed little or no germination in raw seawater from any source, whereas spores of three obligate marine fungi were uninhibited and another only slightly.

The species inhibited by raw seawater were not by autoclaved seawater of the same salinity. Mycostasis was also annulled by heating raw seawater to 50°C for 1 hr., by evaporation and reconstitution with distilled water, charcoal filtration, extraction with organic solvents, and the addition of glucose or ammonium phosphate.

Seawater stored for long periods in polyethylene carboys was more inhibitory than fresh seawater in glass containers, although both types of raw samples supported lower germination percentages than the autoclaved samples. The possibility of interference by ethylene derived from plastic containers was noted. The salinity of media on which spores were produced also affected results.

PHYTOPLANKTON ASSEMBLAGES WITHIN THE CHESAPEAKE BAY PLUME AND ADJACENT WATERS OF THE CONTINENTAL SHELF. Harold G. Marshall. Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

The phytoplankton composition of the Chesapeake Bay plume in its distribution over the continental shelf was seasonally studied during March, June and October 1980. These periods also coincided with an unusually low period of water inflow to the Chesapeake Bay. Criteria used to define the bay plume on the basis of phytoplankton populations within the plume which contrasted distinctly from phytoplankton assemblages outside the plume over the shelf. Different assemblages were noted for each seasonal period for the plume and shelf waters. Dominant plume constituents were *Skeletonema costatum* and an ultraplankton component of apparent mixed populations of cyanophycean and chlorophycean species. The plume was characterized by high cell concentrations of phytoplankters, which were mainly small in size and associated with good growth conditions. Ultra- and nanoplankton components were the dominant forms throughout the sampling period. The shelf species were dominated by coccolithophores and neritic diatoms. Total cell concentrations generally decreased seaward with patchiness common and a slight increase of cells indicated near the shelf break.

This study was supported in part by the NOAA Northeast Monitoring Program.

OBSERVATIONS ON THE FLORA OF THE ANTARCTIC. P.M. Mazzeo. Herbarium, U.S. National Arboretum, Washington, D.C. 20002.

The flora of Antarctica, the only polar continent, is greatly restricted by the most severe weather conditions in any area of the world. Temperatures as low as -88.5°C (-127.3°F) and winds in excess of 125 mph are not uncommon in many areas within the Antarctic Circle (66° 30'S). Also, much of the continent is covered by a permanent ice pack.

As a result of these extreme ecological factors, the flora is limited primarily to cryptogamic plants: algae, lichens, mosses, and liverworts. Two flowering plants, Deschampsia antarctica (Gramineae) and Colobanthus quitensis (Caryophyllaceae), occur only on the Antarctic Peninsula and adjacent islands just beyond the Antarctic Circle.

During a recent trip to the Antarctic, these two phanerogamic taxa were documented with herbarium specimens and photographs now on deposit in the herbarium of the National Arboretum. Each is scattered in exposed rocky soil on or near the shoreline. Fertile material of Deschampsia (from the previous season) was documented from Torgerson Island near Palmer Station, 64°46'S; 64°3'W and at Arctowski Station, King George Is., 62°10'S; 58°28'W. No fertile material could be found for Colobanthus (less common than Deschampsia) documented from the Arctowski Station.

GLOBAL DISEASES OF THE ELM. J. A. Micales, R. J. Stipes, J. L. Ratliff and S. R. Lawrence. Dept. Plant Pathology & Physiology, VPI & SU, Blacksburg, VA 24061

Although the pathology of the genus Ulmus has been dominated by Dutch elm disease since the 1930's, these trees are subject to a variety of other disorders. These include at least 4 other vascular diseases, including elm yellows (which is caused by a mycoplasma-like organism) and bacterial wetwood, as well as more than 44 leaf spots, 16 cankers, 14 root diseases and 17 wood decays caused by an assortment of fungi, bacteria, nematodes and viruses. Abiotic stresses, such as those induced by mechanical injury, construction damage, exposure to agricultural gases and chemicals, and de-icing salts, are also important factors on most landscape sites.

This is not to diminish the importance of Dutch elm disease, which has gained status as one of the most well-known plant diseases of all times, along with late blight of potato, black stem rust of wheat and chestnut blight. The highly valued American elm is particularly susceptible to the disease, and a portion of America's past has died with these majestic trees. Dutch elm disease can be managed successfully, however, by an integrated system which combines sanitation, vector control, and root graft severance, along with surgical excision of diseased tissues and the injection of systemic fungitoxicants.

BOTANICAL ASPECTS OF THE GENUS ULMUS. J.A. Micales, R.J. Stipes, J.L. Ratliff , and S.R. Lawrence . Dept. Plant Pathology and Physiology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061

There has been a renewed interest in the taxonomy of the genus Ulmus as researchers look for new hybrids and cultivars of elm which are resistant to Dutch elm disease. Elms belong to the family Ulmaceae of the order Urticales; this family contains over 15 genera and 150 species, 32 of which are currently recognized as belonging to Ulmus. China is believed to be the center of greatest diversity of the genus. Many new cultivars of elm have been produced by hybridizing various species. American elm is the only tetraploid species in the genus and has not been extensively used in breeding programs. The Dutch have recently produced several new clones - 'Dodoens,' 'Lobel,' and 'Plantyn' - which are reportedly resistant to both the aggressive and non-aggressive strains of Ceratocystis ulmi. Other hybrids have been produced in the United States and include 'Sapporo Autumn Gold' (U. pumila X U. japonica) and 'Urban' elm (U. carpinifolia X U. pumila). Huntingdon elm (U. X hollandica 'Vegeta') is England's most resistant elm cultivar and is being planted throughout the country. Zelkova serrata, another member of the Ulmaceae, is being used as a substitute for elm on many American landscapes.

ARCHITECTURAL ANALYSIS OF APPALACHIAN OAK FORESTS IN SOUTHWEST VIRGINIA. L. Oosterhuis* and T. L. Sharik, Dept. of Silviculture, State Agricultural University Wageningen, The Netherlands, and Dept. of Forestry, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061

The architectural analysis of forest structure has been developed in the tropics during the past decade. The analysis distinguishes between growing, dynamic and mature, more static stages in forest development. The structure of a mature forest can be described in terms of the presence of sets of trees, i.e., the set of the future, present and past. Each tree is designated to a set on the basis of its potential for expansion in the architectural sense.

In the Brumley Gap study area of southwest Virginia thirteen forest profiles were constructed, two of which are presented in detail. The profiles show that the forests in the area have not yet fully matured. Reconstruction lead to the recognition of two major disturbances affecting the structure of the forests, i.e., logging at the beginning of this century and the chestnut blight (c. 1930). Architectural analyses provide rapid insight into the structure and dynamics of forests. The approach may be of great value in ecological studies and may have important applications in forest and wildlife management.

RECONSTRUCTION OF STREAMFLOW RECORDS FROM TREE-RING SERIES IN NORTHERN VIRGINIA. R. L. Phipps, Tree-Ring Laboratory U. S. Geological Survey, Reston, VA. 22092.

Monthly values of summer season streamflow on the Occoquan River, 1841-1975, have been estimated from tree-ring series. Seven collections representing six species at sites in northern Virginia were collectively calibrated with existing streamflow data for each month, April through August, 1928-1975. Calibration results were then applied to the tree-ring series to estimate streamflow. Estimates for June, July, and August were judged most reliable. Major mid summer flow minima were reconstructed as having occurred in the early 1870's, the early 1930's, and the mid 1960's. A greater frequency of extreme low flow during summers of individual years is indicated for the entire record than for the most recent 50 years.

VEGETATION OF THE BALSAM MOUNTAINS,VA.: A PHYTOSOCIOLOGICAL SURVEY. R. D. Rheinhardt* and S. A. Ware. Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

A quantitative phytosociological survey was made of the herbaceous and woody vegetation of the Balsam Mountains in southwest Va. These forests were compared with those of other areas with similar elevation and topography and tested for significant correlation between community structure and environmental variables. Altogether, 69 stands were sampled (21 extensively) between 950 and 1750 meters in elevation at various slopes and aspects. Stands were positioned on a 3-axes vegetational mosaic using a Bray-Curtis ordination. Correlational analyses were then performed to compare stand position with the measured environmental variables. Important and/or abundantly represented species were then plotted separately on these ordinations.

Most stands proved to be much more mesic in composition than forests of similar elevations and topography occuring throughout the rest of the Blue Ridge. One fairly extensive community-type of open slopes closely resembles the mixed mesophytic forests of the Cumberlands and the cove forests of the Great Smokies in vegetational complexity; it differs only in that it occurs at higher elevations and therefore lacks the lower elevational constituents normally associated with the mixed mesophytic forests. In general, species tended to correlate predictably with most environmental parameters; however, a few unanticipated correlates were discovered.

OAK REGENERATION DEVELOPMENT AFTER CLEARCUTTING IN THE RIDGE AND VALLEY PROVINCE OF VIRGINIA. M. S. Ross*, T. L. Sharik, and D. Wm. Smith, Department of Forestry, VPI & SU, Blacksburg, VA 24061

Oak stump sprout development was observed two years after whole tree harvesting in southwestern Virginia. Sprout production was investigated as a function of species, vegetation type, and characteristics of the cut tree. Species had an important effect on both the ability of a stump to produce at least one sprout, and the amount of sprout material produced, with Quercus prinus exceeding Q. coccinea and Q. velutina in both cases. The relationship of sprouting with vegetation type was less obvious; types associated with relatively dry conditions appeared to support more dependable oak sprouting, although trends in sprout biomass production were less apparent. Age, diameter, height, and basal area increment of the parent trees were negatively related with the frequency of sprouting, but positively associated with production in those stumps which did sprout. However, variation in the response of individual stumps was high, and R^2 values for production variables were generally in the .2 - .4 range.

PHYTOPLANKTON COMMUNITIES: CONTINUOUS OR DISCRETE EVENTS. Charles K. Rutledge* and H. G. Marshall. Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

Kruskal's multidimensional scaling algorithm was applied to selected phytoplankton data to study the variation in seasonal community structures. The primary data base consisted of eight cruises from the northeast coastal waters of the United States. The cruises occurred between October 1978 and July 1980. From this primary data base, two groups of 24 stations each were randomly selected from stations located between 35°N and 39°N Latitude. The two groups represented onshore versus offshore community types using the 30-mile isopleth as a discriminator. This data sampling strategy was chosen to assure pronounced community structural differences between cruises and between distance from shore subgroups. Inter-sample similarity was calculated using Czekanowski's formula on log-transformed cell/liter data. The results are a spatial representation of samples relative to each other using the similarity coefficients as distance functions.

The results illustrate the emergence of different phytoplankton community structures throughout the year, and a different onshore versus offshore response. The lack of noticeable station-point clustering in any dimension by the stations of the seasonal subgroups suggest changes in phytoplankton community structure are continuous as assessed by the MDS technique.

This study was supported in part by the NOAA Northeast Monitoring Program.

SUCCESSIONAL CHANGES IN PIEDMONT VIRGINIA FORESTS. M. J. Scanlan. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

In 1976 and 1979 five Virginia Forest sites were intensively sampled to determine the direction and magnitude of change during post-logging succession. Although there are compositional differences between these forests and those sampled by Oosting in North Carolina (1942), the stable, terminal community on the uplands in Piedmont, Virginia is similar to the North Carolina white oak-hickory type.

The recorded changes in the tree populations demonstrate that logging encourages or discourages growth and reproduction among the species. These alterations have been viewed as evidence of competitive ability and successional pattern mapped accordingly. However, when viewed as evidence of either competitive or stress-tolerance strategies the predicted outcome of succession is different.

UNDERSTORY FORAGE IN CONVERTED LOBLOLLY PINE, *Pinus taeda*, PLANTATIONS OF THE VIRGINIA PIEDMONT FROM TIME OF ESTABLISHMENT TO FIRST THINNING. John J. Scanlon*, and Terry L. Sharik. Dept. Fisheries & Wildlife Sci., Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

A double-sampling technique was used to estimate seasonal standing crops of forage in the 0-2 m stratum of second growth, upland hardwood stands, and 2, 5, 11, and 17 year old loblolly pine plantations in the Virginia Piedmont. Samples were taken during the spring (April, May, and June), and fall (September, October, and November) seasons, 1980. Two and 5 year old stands maintained a significantly higher standing crop of forage in all months, when compared with the older stands, and reached maximum levels (190 g/m^2) in June. Eleven year old stands, which had attained crown closure, reached a maximum standing crop of 107 g/m^2 in June. Seventeen year old stands exhibited maximum forage levels (35 b/m^2) nearly equal to those observed in second growth hardwood stands. In early spring, 2 and 5 year old plantations provided the greatest amount of forage (48 g/m^2 and 40 g/m^2, respectively), while during late fall, 5 year old plantations maintained the largest standing crop of forage (24 g/m^2). Conversion of upland hardwoods to loblolly pine results in elevated forage levels for 8 to 10 years. Commercial thinning, applied at 20-25 years may result in a second pulse of understory production to levels well above those associated with hardwood stands formerly occupying these sites.

THE VASCULAR FLORA OF THE KERSEY-CRUMP CREEK WATERSHED, HANOVER COUNTY, VIRGINIA. E. R. Smith and William S. Woolcott. Dept. of Biology, Univ. of Richmond, Richmond, Va. 23173.

A floristic survey was conducted in the Kersey-Crump Creek watershed, Hanover County, Virginia from spring 1978 through summer 1980. This upper Coastal Plain area (42 km^2) near the fall line yielded 514 species of vascular plants, representing 334 genera and 113 families. Four hundred and seventy-nine county records were established. Panax trifolium, colonizing a rich wooded creek bottom, was the only plant rare to Virginia. Voucher specimens are deposited in the herbaria of the University of Richmond, Virginia, and the College of William and Mary, Williamsburg, Virginia.

THE ELM IN HUMAN HISTORY. R. J. Stipes, J. A. Micales, J. L. Ratliff and S. R. Lawrence. Dept. Plant Pathol. & Physiol., VPI & SU, Blacksburg, VA 24061

From the best sources extant, we estimate that there are about 136,000,000 elms on the earth, in contact with about 25% of the human population. They occur naturally on 4 continents (Europe, Africa, Asia and North America), but have been planted by man in Australia and South America. Elm culture goes back thousands of years, the first written report recorded by Homer. The elm is one of mankind's prized landscape trees, and has also been used for medicine, food, fodder, shelter, protection, religious rituals, tools, vehicles, boats, machines, plows, weapons, coffins, recreation and other amenities. To a forester, elm is wood. To the botanist, it is a complex, dynamic and enigmatic macroorganism. To the chemist it is cellulose and lignin, and to the arborist and nurseryman, it is a source of employment and income. The college alumnus sees it as a campus landmark, the city forester as a headache, the city manager as another problem and the tax collector as another loss. To the farmer, it is fuel and boundary. To the landscaper it is form and beauty. In the history of Western Civilization, there are few trees with such a record of wide use, diversity and affection. In a true sense, the elm is a child of civilization.

DESCRIPTIVE VEGETATIONAL STUDIES IN THE CENTRAL COASTAL PLAIN OF VIRGINIA. Stewart A. Ware, Dept. of Biology, College of William and Mary, Williamsburg, VA 23185. Forest stands sampled by the Bitterlich and/or point-centered quarter method have been used to construct separate Bray-Curtis ordinations for small stream swamps and uplands. Red maple, ash, and American elm dominate in wetter, more fertile, less acid swamps. Water oak, willow oak, sweet gum, and (in selectively cut sites) American hornbeam dominate in less moist, less fertile, more acid swamps. Loblolly pine, white oak and beech fail to correlate with soil chemistry, but reflect increasing age of the stand since cultivation. Beech dominance was not correlated with steep slopes. Virginia pine and tuliptree importance are related to past partial disturbance of loblolly pine or pine-white oak stands, respectively. Hickories are also more important in disturbed hardwood stands. Sweet gum, coming in abundantly under loblolly pine, rarely reached canopy size in uplands. Forests were rather different in composition from Piedmont forest stands, and showed their closest relationship to the beech-white oak end (as opposed to the laurel oak-sweet gum-hickory end) of the Southern Mixed Hardwood Forest gradient of the southeastern Coastal Plain.

VASCULAR PLANTS IN SEASHORE STATE PARK NOT INCLUDED IN
FRANK E. EGLER'S CHECK LIST (1942). Joan B. Wright*,
Judith L. Kernell*, and Gerald F. Levy. Dept. of Biological
Sciences, Old Dominion Univ., Norfolk, Va. 23508

This paper reports vascular plant species found growing
within the boundaries of Seashore State Park, Virginia Beach,
Virginia, that were not reported by Frank E. Egler (1942) in
his Check List of the Ferns and Flowering Plants of the
Seashore State Park. The study is based on collections made
from a wide diversity of sites throughout the park and along
a transect which extended from the southern park boundary at
Long Creek to the northern park boundary at Chesapeake Bay.
Of the 203 species of fall and perennial flora collected,
51 species encompassing 39 genera belonging to 31 families
were found not to be on Egler's check list. Field work was
conducted during September 1980 through April 1981. Con-
tinuing collections through the spring and summer may yield
noteworthy additions.

COMPARISON OF DECAY RATES OF CONFINED VERSUS UNCONFINED
LITTER IN THE GREAT DISMAL SWAMP. F.K. Yates* and F.P.
Day,Jr. Dept. of Biological Sciences, Old Dominion
Univ., Norfolk, Va. 23508.

Data collected from two previous years suggests that
both frequency and duration of flooding have a strong infl-
uence on decomposition and nutrient turnover rate (N, P, K,
Ca, & Mg) in the swamp. This study was executed in order to
1) obtain a third year of data for evaluating year to year
variation, 2) to compare litter bag techniue of rate deter-
mination with the unconfined leaf pack technique, and 3)to
to compare both of these methods with a pure cellulose sta-
ndard for decomposition. A secondary objective is to qual-
itatively evaluate soil fauna coponents. 1980 has been the
driest year on record for south-eastern Virginia. Data are
compared with the two previous "normal" years and an asses-
sment of drought impact in the swamp is noted.

Chemistry

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University

SYNTHESIS AND PROPERTIES OF THE SODIUM METABISULFITE-SODIUM FORMATE COMPLEX. R. L. Ake, D. M. Oglesby. Dept. of Chem. Sciences, Old Dominion University, Norfolk, VA 23508 and D. Snyder, Va. Chem. Inc., Portsmouth, VA.

Ertl and coworkers reported the formation of a double salt of sodium metabisulfite and sodium formate, having the formula $Na_2S_2O_5 \cdot NaHCO_2$ during the synthesis of sodium dithionite by the so called formate process (G. Ertl, V. Kiener, W. Ostertag, and Gerd Wunch, Angew. Chem. Int. Ed. Engl. 18 (1979), No. 4).

A reproducible method for the synthesis of the double salt has been developed in our laboratory (Virginia Chemicals, Inc.) which gave a 24% yield of the salt having the formula $Na_2C_2O_5$, $NaHCO_2$. The Analysis for $Na_2S_2O_5$ was 72.14% vs a calculated value of 73.6%.

The x-ray diffraction powder pattern was determined and found to be the same as that reported by the German workers. Differential thermal analysis shows an endothermic decomposition at 122°C. The electron spin resonance (ESR) spectrum as a function of temperature was recorded and revealed only a weak signal of unknown origin at 80K. However, a strong, relatively isotopic ESR signal appeared as the sample was warmed above 320°K. The temperature dependance and spectral characteristics of the signal were compared with those from $Na_2S_2O_4$ and $Na_2S_2O_5$.

BIOCHEMICAL ANALYSIS OF HUMAN SEMINAL FLUID. J. Ayub and J. H. Yuan, Dept. of Chem. Sci., Old Dominion Univ., Norfolk, Va., 23508

Human semen is emitted at the time of ejaculation and is a viscus secretion of the primary and secondary male genital glands. The secretion is composed of spermatozoa and seminal fluid. Seminal fluid serves as a medium for transport of spermatozoa, and composed of the secretions from prostate, seminal vesicle and epididymis. Prostatic fluid is characterized by a high citric acid and acid phosphatase as well as absence of reducing sugars, protein and prostagladins. An absence or low level of any of these constituents may suggest dysfunction or obstruction of the specific accessory gland. At present, there is no single criterion for differentiating fertile and infertile male. We have thus set forth to study the normal range of fructose, protein, glycerolcholine, acid phosphatase and citric acid levels in normal fertile male. The results of these studies will be presented.

THE PREPARATION OF 9-PHENANTHRENETRIBUTYLAMMONIUM METHANESULFONATE. D.W. Armstrong, W.S. Ashe, E.S. Dummitt, III, C.H. Greatwood, M.E. Robson, J.K. Shillington and S.W. Snyder, Department of Chemistry, Washington and Lee University, Lexington, Va. 24450

It is known that many aromatic compounds are carcinogenic and/or cancer drugs. It is thought that this may involve the stacking of the aromatic ring systems of the bases in DNA and RNA to form a hydrophobic core in the helix. This is surrounded by the ribo-phosphate strands coated with protonated amines called histones which offset the negatively charged phospho groups.

We are attempting to synthesize a series of large aromatic quaternary ammonium salts which we hope may insert themselves into this hydrophobic-hydrophilic system with the result that the core of the helix will be altered and replication interrupted, perhaps interfering with the cells' growth.

This paper deals with the synthesis and modification of aromatic tributylammonium salts with emphasis on a particular salt derived from phenathrene.

INVESTIGATION OF ALTERED DIET ON MEMBRANE FATTY ACID PROFILE OF EHRLICH ASCITES TUMOR CELLS. T, Baldwin and L. Wolfinbarger, Jr. Dept. of Biological Sciences, Old Dominion University, Norfolk, Va. 23508

This paper represents a preliminary study of the fatty acid profiles of Ehrlich ascites tumor cells grown in mice on different dietary supplements. Membranes of tumor cells grown in mice on a diet high in saturated fatty acids (coconut oil supplement) show a higher percentage of saturated and monenoic fatty acids than those membranes from tumor cells grown in mice on a diet high in unsaturated fatty acids (sunflower seed oil supplement).

The fatty acid profiles of membranes from these two groups are correlated with a control tumor cell membrane preparation isolated from ascites cells grown in mice on a nonsupplemented diet. Experimental procedures consist of membrane lipid extraction, silicic acid column chromatography, derivatization and analysis on gas/liquid chromatograph.

NEUTRON ACTIVATION ANALYSIS AT THE UNIVERSITY OF VIRGINIA. P.E. Benneche* and B.L. Shriver. Dept. of Nuclear Engr. & Engineering Physics, Univ. of Va., Charlottesville, VA 22901.

The University of Virginia Department of Nuclear Engineering and Engineering Physics owns and operates a two megawatt research reactor. The reactor is used for research, graduate and undergraduate thesis projects and student laboratories. Some special classes and research by students and professors at other universities are also conducted with grants through the Department of Energy's Reactor Sharing Program.

Neutron activation analysis is the process by which a non-radioactive sample of unknown composition is placed in a neutron flux which transforms a small amount of each element in the sample into radioactive isotopes. The quantity of each isotope produced is established by the amount of each element present in the sample, the level of the neutron flux and the irradiation time. Each of the isotopes emits characteristic gamma rays by which the elements in the sample can be identified. When the sample is counted on sensitive solid state radiation detectors the precise amount of each element can be determined.

At the University of Virginia we are currently able to analyze a sample for over 50 different elements. Examples of the application of neutron activation analysis to research projects will be discussed. The use of the neutron activation analysis facilities at the University of Virginia is encouraged.

A CONVENIENT PROCEDURE FOR THE SYNTHESIS OF RADIOLABELED PEPTIDES. J. Castellano and L. Wolfinbarger, Jr., Dept. Biol. Sci., Old Dominion Univ., Norfolk, Va. 23508

Traditional procedures for the synthesis of small peptides employ deblocking steps which may derivatize the peptide in addition to deblocking it. The procedure described here utilizes benzyl esters of carboxyl groups on peptides and amino acids and carbobenzoxy (CB2) - amino acids with the traditional coupling reagent dicyclohexylcarbodiimide (DCCD). The advantage lies in subsequent simultaneous deblocking of both protective groups by use of formic acid/methanol as the solvent and palladium black as the deblocking agent.

STUDIES OF APOPROTEINS FROM HUMAN HIGH DENSITY LIPOPROTEIN. C. Chin and J. H. Yuan, Dept. of Chem. Sci., Old Dominion Univ., Norfolk, Va., 23508

Over the last several years an intensive investigation has focused on the identification of risk factors for the development of premature atherosclerosis. Recent research suggested a negative coorelation between high density lipo-protein(HDL) cholesterol in human plasma and risk of premature heart disease. Apoproteins, ApoA-I and ApoA-II are two major protein constituents of HDL. ApoA-I was reported to activate lecithin cholesterol acyltransferase(LCAT). However, the function of ApoA-II still unclear. Our research focus on the study of the effect of ApoA-II modulation of HDL composition. We also attempted to develop a method suitable for clinical laboratory for routine analysis of HDL subclasses, HDL_2 and HDL_3. The detail of the method will be presented. (Supported by a grant from Va Affiliate of American Heart Association)

POLYAMINE-NUCLEOTIDE INTERACTIONS: LEAST SQUARES ANALYSIS OF A NON-LINEAR SYSTEM. L. G. Clary, W. H. Voige, and J. J. Leary*. Dept. of Chemistry, James Madison University, Harrisonburg, Va. 22807

An improved mathematical model for the calculation of polyamine-nucleotide formation constants is presented. It will be demonstrated that the basic equations are always non-linear in coefficients and, in general, are higher order in polyamine concentration. Further, it will be demonstrated that approximations can be made, and that new equations which are linear in coefficients can be written. Finally, it will be shown that these equations are functionally correct and that the formation constants obtained using this approach often differ significantly from those obtained using earlier methods.

STUDIES ON ANTITUMOR AGENTS WHICH INHIBIT RIBONUCLEOTIDE REDUCTASE ACTIVITY IN EHRLICH ASCITES TUMOR CELLS. K. Friel, R. L. Williams, L. Wolfinbarger. Dept. Biology, Old Dominion University, Norfolk, Va. 23508

A variety of α-(N)-heterocyclic thiosemicarbazones have been synthesized and evaluated for antineoplastic activity in transplanted animal tumor systems. The generally accepted mechanism of action suggests that the α-(N)-heterocyclic thiosemicarbazones block DNA synthesis in tumor cells by inhibiting ribonucleotide reductase, either by chelation of the compound with the enzyme dependent ferrous ion, or through a preformed metal chelate which inhibits reductase activity. The objective of this paper is to describe the evaluation of a series of new semicarbazones and thiosemicarbazone derivatives of the di-2-pyridyl and 1,8 diazafluorene ring systems. Our preliminary evaluation of these agents against transplanted Ehrlich ascites tumor cells in mice have shown them to exhibit a relatively high level of activity as compared to certain standard α-(N)-heterocyclic formyl thiosemicarbazones. This preliminary in vivo activity has been complimented by specific enzyme studies which have shown that these systems do in fact exhibit the potential to inhibit ribonucleotide reductase activity.

THE ANALYSIS OF S-ADENOSYLMETHIONINE AND S-ADENOSYLHOMOCYSTEINE IN NORMAL AND NEO-PLASTIC CELLS. K. E. Godburn and T.O. Sitz, Dep't. of Chemical Sciences, Old Dominion University, Norfolk, VA. 23508.

Altered patterns of methylation have been shown in both ribosomal and transfer RNA isolated from cancer cells. In contrast to the elevated activity of the methytransferases responsible for this modification, hypomethylation appears as a general characteristic. The endogenous levels of S-adenosylmethionine (SAM) and S-adenosylhomocysteine (SAH) are important to their role in relationship to their substrate and product of the transmethylation reactions. Rat cells of high passage were characterized by an increase in the ratio of SAM to SAH in addition to a decrease in the quantities of both compounds. In human cells the concentration of SAM was increased in neoplastic cells. The ratio of SAM to SAH was inversely related to the methylation levels in 5.8S rRNA suggesting that the levels of SAM and SAH do not control RNA methylation, but rather the methylation levels influence the SAM and SAH levels.

LARGE SCALE ISOLATION OF 5.8S rRNA FROM MAMMALIAN TISSUE FOR CONFORMATIONAL STUDIES. G. D. Howell and T. O. Sitz, Chemical Sciences Department, Old Dominion University, Norfolk, VA 23508.

The mammalian 5.8S rRNA contains two 2'-o-ribose methylated positions in its sequence. Position 14 contains a partially modified uridine (U_mG) which was found to vary from 0.15 to 0.85 molar amounts in a variety of tissues with the lowest yields in cancer cells. The U_mG modifications occur as a late cytoplasmic modification which has an effect on the conformation of the 5.8S rRNA. This may have important consequences for how the molecule functions in protein synthesis. Methods have been developed to isolate large amounts (mg. amounts) of 5.8S rRNA for conformation studies. Since 5.8S rRNA is hydrogen bonded to the larger 28S rRNA molecule, it can be partially purified by differential salt precipitation. Further purification was achieved by melting the 28-5.8S rRNA complex and removing the larger RNAs by salt precipitation. Final purification was accomplished by gel permeation chromatography on S-300 sephacryl. The 5.8S rRNA peak was then allowed to dimerize and reapplied to the column to remove co-migrating contaminants.

Optimization of Rare Earth Chlorides in Acetal Formation. Susan A. Howell*, Junaid A. Siddiqui, Raphael M. Ottenbrite. Dept. of Chemistry, Va. Commonwealth Univ., Richmond, Va. 23284.

We have investigated the scope and limitations of utilizing trichlorolanthanide compounds in acetal formation of substituted benzaldehydes. It was observed that higher acetal yields were obtained for those aldehydes with para-substituted electron-withdrawing groups such as p-nitro (97%) compared to the unsubstituted benzaldehyde (85%). Strong electron-donating groups such as para-methoxybenzaldehyde were observed to affect a significant reduction in acetal formation.

Generally, the reaction went to completion in 15 minutes and yields were not appreciably increased with extended reaction times. An exception to this was neodymium trichloride with para-methoxybenzaldehyde, which showed no observable reaction after 15 minutes, but an 8% conversion after 18 hours.

The activity of the catalyst changed with time. The greatest effectiveness was in the first 2 or 3 days and approximately a 10% decrease was observed for each day after. It was also observed that the effective concentration of catalyst varied significantly with the substrate used. The present data seems to indicate that there could be more than one mechanism involved in the process.

DETERMINATION OF N,N[1]-DIPHENYLGUNNIDINE (DPG) IN BIOLOGICAL MEDIA BY HIGH PRESSURE LIQUID CHROMATOGRAPHY (HPLC). E. S. Hunter, III and F. E. Scully, Jr., Department of Chemical Sciences, Old Dominion University, Norfolk, VA 23508 and M. A. Bempong, Department of Biology, Norfolk State Univ., Norfolk, VA 23504.

DPG is used as an accelerator in processing rubber; the necessity of its determination has been shown as DPG has been found to be mutagenic by Ames Assay.

Using a solution of 70% Sodium Hypochlorite and 30% Ethanol as a TLC spray is a novel method for the qualitative determination of >10 micrograms of DPG.

HPCL analysis using UV detection is sensitive for the determination of 1×10^{-7} grams of DPG. Since a more sensitive method was required and since DPG itself does not appreciably fluoresce, fluorescent labelling was next attempted. Derivitization with o-phthalaldehyde and ninhydrin or condensation with dibenzoylmethane and sodium p-toluenesulfinate all failed to yield a fluorescent product.

Reaction with 1-dimethylamine-naphthalene-5-sulfonyl chloride (DANS-Cl) produces a fluorescent product when reached in 10-100 molar excess with a Sodium Bicarbonate saturated DPG standard solution (Details will be given).

Urine was collected from rats chronically treated with DPG in their drinking water and from control rats. DPG was extracted from the urine, and diluted to volume, saturated with sodium bicarbonate and reached with Dans-Cl.

THE FUJITA-BAN METHOD FOR PREDICTING DRUG ACTIVITY: A SIMPLE CHEMICAL EXAMPLE. A. L. Johnston, C. Nguyen, D. S. Amenta, and J. J. Leary*. Dept. of Chemistry, James Madison University, Harrisonburg, Va. 22807

Many predictive methods have been used by the pharmaceutical industry for the estimation of drug activity. The approach of Fujita and Ban is one such method which is both readily understood and easily used. This method will be described from both a conceptual and a mathematical viewpoint. A simple, purely chemical example will be presented and developed for the prediction of pKa values of hydroxyl substituted benzoic acids. Results will then be presented for the application of the Fujita-Ban method to the prediction of pKa values for a much larger and more general set of benzoic acids. The results illustrate the utility of this method for predicting chemical, as well as biological activity.

A COMPUTER DETERMINATION OF 2V OF ANTHRACENE FROM EXTINCTION DATA. Maureen M. Julian Dept. of Geological Science, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

In biaxial crystals, measurement of the angle between the two optic axes, 2V, is constant for a given crystal, at a given temperature, and for a given wavelength. A study of the optical properties of anthracene was done because of conflicting results in the literature and because recently developed techniques (Bloss 1981) introduce computer and statistical methods into the practise of optical crystallography permitting greater accuracy. The work was complicated by the fact that the anthracene crystal rapidly dissolves in immersion media. Data was completed on four separate crystals, three at 540nm and one at 900 nm. The data was analyzed by the Bloss-Riess-Roher program "excalibr" using Joel's equation to find the optic axes and refinement was done by least squares to calculate an accurate 2V. Crystalline refractivities were calculated from the refractive indices. The molecular refractivites were calculated from a combination of the crystalline refractivities and information on the packing and shape of the molecules.

Bloss, F.D. "The Spindle Stage:Principles and Practice" CUP 1981

DETERMINATION OF NIOBIUM AND OTHER TRACE ELEMENTS IN SELECTED HUMAN TISSUES. P. W. Kaczaral, G. C. Grant and C. Djordjevic, The College of William and Mary Research Campus (Newport News) and Williamsburg Campus, VA.

Niobium lies just under vanadium and next to molybdenum in the periodic table. Both of these are trace elements essential to life. A few reports have indicated ppm levels of niobium in certain tissues, which would be consistent with an essential role as an enzyme constituent.

Accordingly three analytical methods for the determination of niobium in human tissues were investigated: graphite furnace atomic absorption spectrophotometry, flame atomic absorption and Proton-Induced X-ray Emission (PIXE). All attempts by furnace atomic absorption were unsuccessful including matrix modification procedures (no furnace method has been published for Nb). Flame atomic absorption methods were reproducible, but detection limits were only ca. 10 ppm - inadequate for tissue analysis.

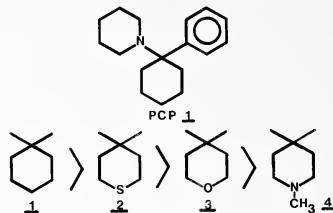PIXE methods were reproducible and gave typical detection limits of 0.1 µg/g tissue (dry weight). Recoveries of niobium spiked bovine liver (NBS SRM 1577) were 90 percent and results for other trace elements were in accord with published values. In kidney, aorta, brain and spleen niobium was less than 0.10 µg/g in contrast with previous published values of 4.74, 6.23, 1.61 and 1.36 µg/g respectively.

DETERMINATION OF URINARY OXALATE WITH A POTENTIOMETRIC ENZYME ELECTRODE. R.K. Kobos, J.A. Morrissey*, and P. Burnet*. Dept. of Chemistry, Virginia Commonwealth Univ., Richmond, VA 23284.

A highly selective enzyme electrode system for the determination of urinary oxalate has been developed. The oxalate sensor utilizes oxalate decarboxylase chemically immobilized on a carbon dioxide gas-sensing electrode, which measures the CO_2 produced by the enzymatic reaction. The response of the system is linear with the logarithm of the oxalate concentration between 2×10^{-4} and 1×10^{-2} M with a slope of 55-60 mV/decade. The lower limit of detection is 4×10^{-5} M, which is below the normal range of urinary oxalate levels. There was no decrease in this response after one month of daily use. Selectivity studies indicate that the sensor is not affected by the normal constituents of urine and therefore can be used to directly measure oxalate in urine samples. Recovery studies of oxalate added to human control urine samples gave an average recovery of 97.7%. Artificial urine samples were analyzed with an accuracy and precision of 5 to 6%. (Aided by a grant from Research Corporation).

THE CHEMISTRY OF GALLSTONES. Joyce D. McKnight* and Maureen M. Julian, Hollins College, VA. 24020

Samples of gallstones were collected from the pathology departments of three Roanoke, Virginia hospitals. Stones were tested for cholesterol, which is found in more than 75% of the stone, by dissolving a small amount of the stone in chloroform and a few drops of H_2SO_4, which will give a red ring around the bottom of the test tubes if the test is positive.

Calcium carbonates can be present in three forms: Calcite, Aragonite and Vaterite in decreasing stability. The HCl test was used to test for carbonates. Metal carbonates such as Calcium, Magnesium, Lead, Zinc, Cobalt and Lead. Calcium Phosphate in the form of Apatite and Whitluckite are crystallized from bile and are in the form of calcium salts.

All stones contain amorphous organic matrix, which is obtained by placing the stone in a 4% solution of Na^+ salt of chenodeoxycholic acid at room temperature, it gradually takes on a fluffy appearance as the matrix becomes exposed and the crystalline material dissolves.

Infrared, UV, and X-ray diffraction techniques were also used in analysis.

THE TEMPLATE SYNTHESIS OF MERCAPTOETHYL-AMINE-N,S-DIACETATE COMPLEXES. S.M. Ortel*, Substations Test Dep't., Potomac Electric Power Company, Washington, D.C. and T.A. Donovan*, Dep't. of Chemistry, Buffalo State College, Buffalo, N.Y.

The technique of "template synthesis" was employed to prepare the first coordination compounds incorporating an open-chain quadridentate ligand which utilizes three different types of donor atom. Condensation of cysteamine-N-acetic acid with chloroacetic acid in an alkaline environment in the presence of appropriate metal ions produced neutral tetracoordinate complexes of mercaptoethylamine-N,S-diacetate with Mn(II), Fe(II), Co(II), Ni(II, Cu(II), and Zn(II). These complexes were characterized by elemental analysis and by measurement and interpretation of their ultraviolet, visible, and infrared spectra. Magnetic moment determinations were also made for some of the complexes.

HETEROCYCLIC ANALOGS OF PHENCYCLIDINE. D. McKenney and R. L. Williams. Dept. of Chemical Sciences, Old Dominion University, Norfolk, VA 23508.

Phencyclidine (PCP) 1 has become one of the nation's leading drugs of abuse. In an effort to investigate PCP's structure activity relationship in terms of its receptor interaction, this laboratory has synthesized a series of heterocyclic analogs 2, 3, and 4. These analogs have been evaluated in terms of their gross behavior effects and ability to produce motor impairment using the Screen Test. Though none of the analogs were as potent as PCP the order of activity in this series has been established.

PCP 1

1   2   3   4

SYNTHESIS AND THERMOCHEMICAL STUDIES OF LITHIUM DITHIONITE. D. R. Mitchell and D. M. Oglesby, Dept. of Chemical Sciences, Old Dominion University, Norfolk, VA 23508.

Two methods for the synthesis of lithium dithionite have been developed. Both are based on the reduction of sulfur dioxide by lithium formate in a methanol-water solution. One method, based on U.S. patent #3, 411, 875, involved the addition of sulfur dioxide to a methanol-water solution of lithium hydroxide to first form lithium sulfite. This solution was then reacted with aqueous lithium formate. The second method, based on patent #2, 010, 615, involved the reduction of lithium formate in a methanol-water mixture of lithium formate and lithium carbonate. The hydroxide based method yielded 92% pure lithium dithionite, based on the iodometric titration of the formaldehyde sulfoxalate of the dithionite ion. Differential thermal analysis was used to compare the decomposition behavior to that of sodium dithionite. X-Ray powder patterns and infrared spectra were also taken.

DETERMINATION OF COPPER AND ZINC IN HUMAN SERUM USING POLARIZED ZEEMAN-EFFECT FLAME ATOMIC ABSORPTION SPECTROSCOPY. P. A. Pleban and A. Munyani. Dept. of Chem. Sci., Old Dominion University, Norfolk, VA 23508.

Correction for nonanalyte absorption is a major problem encountered when using atomic absorption spectroscopy (AAS) for trace metal analysis in biological matrices. Recently, a background correction technique based on the Zeeman effect (1) has been designed for use in flame AAS.

We have determined zinc and copper in a tenfold dilution of human serum. Analyses were performed using a Polarized Zeeman-Effect Atomic Absorption Spectrometer (N.S.A. Hitachi, Model 180-70) equipped with a Zeeman burner accessory.

Copper determinations were made by aspirating the diluted specimen into an air-acetylene flame (2.4 L/min fuel:9.4 L/ min oxidant) and measuring the absorption at 324.7 nm. Replicate analyses of a pooled serum specimen yielded an RSD of 1% (124.3 ± 1.0 ug/L, N = 10). Forty-seven specimens, analyzed using standard additions and comparison to an aqueous calibration curve, gave a linear regression line, Y = 0.973 X + .054, and a correlation coefficient (r) of 0.999.

Zinc analyses utilized an air-acetylene flame (2.0 L/min: 9.4 L/min) at the 213.9 Zn line. Within-run RSD was found to be 1.7% (1.293 ± 0.021 mg/L, N = 10). Comparison of standard additions and direct determinations gave a regression line, Y = 1.02 X - 2.53, and r = .989.

1. Koizumi et al., #504, Pittsburgh Conference, March, 1980, Atlantic City, NJ.

TOWARD 1,6,10-OXO[4.4.4]PROPELLA-2,7,11-TRIENE. M.A. Pleva, J.K. Shillington, D.V. Young, Department of Chemistry, Washington and Lee University, Lexington, Va. 24450.

The current entry to the C_{14}-propellane series is via the cis-4a,8a-bisbromomethyldecalin as developed by Ginsberg et al in the late 1960s. At that time an investigation was under way at our laboratory to synthesize such a propellane via a Diels-Alder condensation between an activated $\Delta^{9,10}$ octalin and a butadiene such as 1-acetoxy-1,3-butadiene. This project has waited upon the actual synthesis of a suitably activated octalin which will act as the dienophile. A number of procedures have been attempted, but most of the procedure and facilities are beyond the capacity of the small undergraduate laboratory.

We are currently exploring the production $\Delta^{9,10}$ octalin-1,5-dione from the decalin-1,5-dione by the formation of a 9,10-hydrohalo intermediate followed by elimination of HX due to steric relief coupled with the formation a conjugated π-system. Formation of $\Delta^{9,10}$ octalin-1,5-dione in large enough amounts to be used as the dienophile in the Diels-Alder condensation is one goal, which may provide an elegantly facile entrance into the C_{14}-propellane series.

INTERFACING OF A PDP-11 MINICOMPUTER WITH A BECKMAN 25 SPECTROPHOTOMETER. J. R. Thweatt*, and J. D. Van Norman. Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, Va. 23508.

The interfacing of the PDP-11/10 minicomputer with a Beckman 25 spectrophotometer resulted in an on-line computer system which could be applied to enzyme kinetics studies.

An analog voltage signal, corresponding to absorbance, was tapped from the Beckman 25, via its accessory connector, amplified, and fed into the analog-to-digital converter of the AR11 interface. The analog voltage signal was converted to digital data and stored in data files using the THRU program, under control of the PDP-11/10 minicomputer.

FORTRAN data processing programs were used to: open and read each digital data file and calculate absorbances; plot absorbance curves; calculate substrate concentrations and determine linearity of absorbance curves in calculating velocities; determine kinetic parameters by using linear least squares analysis of linear rearrangements of the Michaelis-Menten equation; study various types of inhibitors.

DUMAS AND PREGL REVISITED WITH MASS SPECTROMETRY. Billy T. Upchurch, Dep't. of Chemical Sciences, Old Dominion Univ., Norfolk, VA. 23508 and George M. Wood*, NASA Langley Research Center, Hampton, VA. 23665.

The analytical methodology used in the analysis of organic compounds for hydrogen, carbon, and nitrogen elemental composition was developed by Dumas in 1833 and later improved by Pregl in 1911. These authors developed the methodology under operative temperature conditions which assured complete conversion of the compound to carbon dioxide, water and nitrogen which were subsequently measured gravimetrically and volumetrically. We have utilized mass spectrometry in examining the conversion process for a number of chemical compounds as a function of temperature and with the use of isotope labels have elucidated one unambiguous mechanism. Results of these studies are discussed both in terms of these chemical processes and applicability toward more selective analytical methodology.

CONFORMATIONAL ISOMERS OF MAMMALIAN 5.8S RIBOSOMAL RNA. D. Smith and T. O. Sitz, Chem. Sciences Department, Old Dominion University, Norfolk, VA 23508.

5.8S rRNA occurs in the large subunit of the eucaryote ribosomes and is known to form specific associations with 28S rRNA, tRNA, ribosomal proteins and methyl transferases. The mammalian 5.8S rRNA contains two 2'-O-ribose methylated positions in its sequence. Position 14 contains a partially modified uridine (UmG) which was found to vary from 0.15 to 0.85 molar amounts in a variety of tissues with the lowest yield in cancer cells. When whole cell RNA was separated on polyacrylamide gels multiple bands of 5.8S rRNA were observed, consisting of a set of three intense bands followed by a set of three faint bands. Since oligonucleotide mapping does not show any significant sequence variation between the three intense bands, it is believed that the fastest of the three represents a compact conformation and the slower bands more open conformations. The fastest band is unmethylated, the middle band is approximately 25% methylated, and the slowest band is approximately 75% methylated. When the six bands of 5.8S rRNA are eluted from the gel and then electrophoresed under denaturing conditions, the material from the three intense bands migrates as a single band, and the material from the faint band migrates more slowly as a single band. These faint bands may represent different conformations of an elongated 5.8S rRNA sequence (i.e. an aberrant processing fragment or a precursor).

ELECTRON PARAMAGNETIC RESONANCE SPECTROSCOPY OF OXO-Mo(V) TETRAPHENYLPROPHYRIN COMPLEXES. J. Topich and N. Berger, Dept. of Chemistry, Virginia Commonwealth Univ., Richmond, VA 23284.

Electron paramagnetic resonance (EPR) spectroscopy is a technique which is useful in probing the electronic structure of paramagnetic transition metal complexes. Molybdenum is an important transition metal in both industrial and biological catalytic reactions. We have synthesized a series of oxo-Mo(V)-p-substituted-tetraphenylporphyrin complexes (OMo(V)-p-x-TPP; x = CH_3O, CH_3, H,F,Cl,Br). Tetraphenylporphyrins were chosen as ligands so that the coordination geometry and stereochemistry of the Mo complexes is well defined. The UV-visible spectra for OMo(V)-TPP complexes are indicative of the species present in solution. The solution behavior of these complexes will be discussed. Shifts in the energies of the electronic transitions are seen when the ligand substituent is changed. In addition, isotropic and anisotropic EPR spectra for the Mo(V) complexes are presented. Anisotropic spectra are obtained in a frozen liquid crystal solvent. The liquid crystal EPR results allow for the unambiguous assignment and calculation of $g_{\parallel}$ and $g_{\perp}$ especially when there is overlap between them. The electronic structure of the Mo(V) complexes are discussed in light of the EPR results.

PLANAR SYMMETRY IN PERIODIC DESIGNS. Anna Mary Van Buren* and Maureen M. Julian, Dept. of Chemistry, Hollins College VA, 24020

The study of two-dimensional planar groups is important in the understanding of surface chemistry, as a manageble educational aid to understand the synthesis of symmetry, both two and three dimensions, and as a purely aesthetic treat. This work was inspired by M.C. Escher's ingenius use of interlocking characters to fill two dimensional space. Escher, an artist, never completed designs for all seventeen of the planar groups. The goal of this project is to complete plates for all of the seventeen space filling possibilities. The artistic and mathematical demands are intermeshed. A suitable motif is selected cunningly designed so that the generated and inserted symmetry elements all appear equally plausible. These are carefully drafted onto an appropriate grid. A contrasting "negative" space is generated which must be filled with an appropriate complementary interlocking design.
1. Caroline H. MacGillevey, Fantasy and Symmetry, The Periodic Drawings of M. C. Escher, Harry N. Abrams, Inc. NY 1976.

MOUNT ST. HELENS: THE VOLCANO AND THE ASH. J. P. Wightman, Betty Beck*, and Yoonok Kang . Dept. of Chemistry, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

An analysis of ash collected following the eruption of Mount St. Helens is detailed. Seven samples collected from six locations in Washington were analyzed by scanning electron microscopy/energy dispersive analysis of x-rays (SEM/EDAX) and electron spectroscopy for chemical analysis (ESCA). Data reported in the literature demonstrates that the ash with particle size < 3.5 μm constitutes < 2 wt % of the total ash. Further, it has been demonstrated that the ash is similar in composition to dacite. The SEM photomicrographs show a broad size distribution. Major elements detected by EDAX were Al, Ca, K, Na, Si; minor elements were Fe, Mg and Ti. The following major elements were detected by ESCA: Al, Na, O, Si; minor elements included Ca, Cl, K, and Mg. Good agreement was obtained for the Al/Si, Na/Si and Ca/Si elemental ratios determined by ESCA and those ratios reported in the literature. Cl was detected as a surface component of the ash but not S although high concentrations of both H_2S and SO_2 were measured in the atmosphere following eruption.

KETAMAZONE: ITS SYNTHESIS AND PROPERTIES. R. L. Williams and Ann Booth, Dep't. of Chemical Sciences, Old Dominion University, Norfolk, VA. 23508.

The report of the synthesis of naloxazone, as a potent opiate antagonist, has promoted us to pursue the design of a potential phenycyclidine (PCP) antagonist. In view of the structural similarity of ketamine (1) and PCP (2) we have attempted to prepare the corresponding hydrazone (3) and phenylhydrazone (4) analogs. While the hydrazone could not be prepared a possible phenylhydrazone product was obtained and evaluated against PCP effects. Both naloxazone and this new phenylhydrazone appear to inhibit PCP activity in mice.

(2)   (1)

(3),R=H,(4),R=Ø
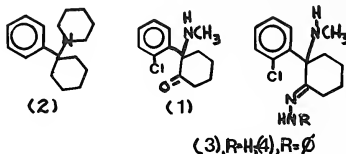
CONDENSATION PRODUCTS OF 6-HYDROXYAMINE WITH VARIOUS CARBONYL COMPOUNDS. R. L. Williams and R. L. Hudkins, Dept. of Chemical Sciences, Old Dominion University, Norfolk, VA 23508.

6-Hydroxydopamine (6-OHDA) is a very potent neurotoxin demonstrating remarkable site selectivity and neuronal toxicity toward the adrenergic nerve system. In 1977 Osswald noted similar characteristics in the action of the tetrahydroisoquinoline (TIQ) derived from the condensation of adrenalin with acetaldehyde, and 6-OHDA although the TIQ was a much less potent neurotoxic agent.

Recently, we have been working on incorporating these two unrelated systems into one molecule, possible increasing both site selectivity and neuronal toxicity. Pictet-Spengler reaction of 6-OHDA and various carbonyl compounds should give rise to the ortho cyclized heterocyclic TIQ analogue of 6-OHDA. Ring closure taking place ortho to the activating hydroxyl function.
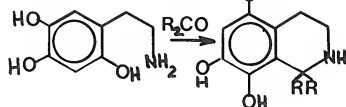

STRUCTURE-ACTIVITY STUDIES OF THE 4, 4[1]-DIPYRIDYL-4, 5, 6, 7 TETRAHYDROIMIDAZO (4, 5-C) PYRIDINE RING SYSTEM. R. L. Williams and Sandra Neergaard, Dept. of Chemical Sciences, Old Dominion University, Norfolk, VA 23508.

4, 4[1]-Dipyridyl-4, 5, 6, 7-tetrahydroimidazo (4, 5-C) pyridine (1) was prepared recently as part of our research program related to the novel condensation of histamine with various carbonyl compounds. During a routine behavioral evaluation (1) was found to exhibit a high degree of convulsant activity. In an effort to study the possible mechanism of action of this agent we have prepared a series of structural analogs (2—6) which we have now evaluated. This paper will discuss the synthesis, evaluation and SAR inherent in the possible mode of action of (1) as a convulsant.

[1] X = N   [3] X = N   [5] X = N
[2] X = C   [4] X = C   [6] X = C
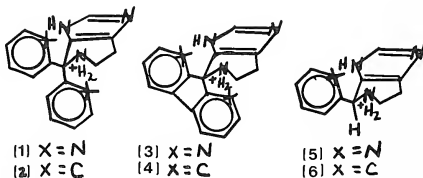
NOVEL SPIROCYCLIC-4, 5, 6, 7-TETRAHYDROIMIDAZO [4, 5-C] - PYRIDINES. R. L. Williams and Sandra Neergard, Dept. of Chemical Sciences, Old Dominion University, Norfolk, VA 23508.

In an effort to prepare a series of PCP (1) analogs, we have synthesized a number of novel spirocyclic tetrahydroimidazo [4, 5-C] pyridines (2—>5). These compounds were obtained by the condensation of histamine free base with various heterocyclic analogs of cyclohexanone in reflecting n-butanol. We will discuss the synthesis and characterization of these new compounds together with an evaluation of their potential biological activity. More of these compounds were found to exhibit PCP like activity, however, some mild analgesic activity was observed with several of these analogs.

(2) X = C   (3) X = O
(4) X = S   (5) X = NAc

(1)
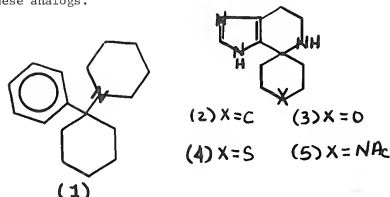
ELECTRONIC STRUCTURES ON A GRAPHICS TERMINAL. John H. Wise, Dept. of Chemistry, Washington and Lee Univ., Lexington, Va. 24450.

Three programs in the CONDUIT package on quantum chemistry have been revised and extended for execution on the Tektronix 4025 graphics terminal connected to the Washington and Lee computer center. The host computer is the Harris S125 employing the Tektronix PLOT 10 software. The programs modified are BOX, CONTOUR, and RADIAL.

BOXER extends the calculations of the energy levels for a particle in a one-dimensional box to include a plot of the wave functions for both the finite well and the infinite well cases.

HYBRID is a revision of CONTOUR to plot the size and shape of the n = 2 orbitals and their hybrid combinations, and DENSITY is a separate revision to plot a dot pattern diagram of electron density for an orbital in the n = 1 to n = 3 shell.

RADIUS presents a plot of the radial density functions of all atomic orbitals from 1s through 4p for a given atomic number followed by a plot of the Hartree-Fock radial distribution for the particular atom.

Examples of the output will be displayed and the applicability of the programs will be discussed.

CHARACTERIZATION OF INTRACELLULAR PEPTIDASE ACTIVITY IN EHRLICH ASCITES TUMOR CELLS. L. Wolfinbarger, Jr., Dept. Biol. Sci., Old Dominion Univ., Norfolk, Va. 23508

Characterization of transport activity for small peptides in Ehrlich ascites tumor cells requires the simultaneous analysis of intracellular peptidase activity. Emphasis is placed on efforts to elucidated one or more peptides which are transportable by membrane localized transport systems but which are not hydrolyzable by intracellular peptidases.

Information to date suggests that the combined intracellular peptidase activity is capable of hydrolyzing peptides of differing requences as well as chain length. Peptides in which glycine is the N-terminal residue are not good substrates and the presence of a D-stereoisomer as the second residue, adjacent to glycine, renders a peptide virtually immune to hydrolysis. (Aided in part by a grant from the ODU Research Foundation.)

AUTOMATED DIFFERENTIAL KINETIC ASSAY FOR HUMAN SERUM CREATINE KINASE-MB ISOZYME, J. H. Yuan and L. W. J. Pan, Dept. Of Chem. Sci., Old Dominion Univ., Norfolk, Va. 23508

It is well established that creatine kinase-MB isozyme (CK-MB) in normal serum is low and scarcely detectable. But following a myocardial infraction, CK-MB activity in serum begins to rise to reach a maximum within 24 hours, and then rapidly returns to normal. The determination of CK-MB has been demonstrated to be specific for the diagnosis of acute myocardial infraction. Different analytical techniques have been developed for quantitation of CK-MB such as column chromatography, electrophoresis, and immunological method. But all these methods are time-consuming, complicated, and skillful technicians are required. We have developed an automated method by using ABA-100 Abbott Biochromatic Analyzer for differential kinetic determination of serum CK-MB isozyme. The method is based on the fact that isozymes often exhibit different catalytic activity and kinetic behaviors with carious substrates. The details of the method will be presented.

Education

**Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University**

CHANGES IN BALANCE AND HAND-EYE COORDINATION OF EDUCABLE MENTALLY RETARDED ADULTS AFTER AN EIGHT-WEEK SWIMMING PROGRAM G. H. Bell*, Jr., K. P. Bovard, R. K. Stratton*. Depts. of HPER and Animal Science, Va. Tech, Blacksburg, Va. 24061

In March, 1980, 38 adolescent educable mentally retarded (EMR) clients, aged 13-46 years were enrolled in an eight-week therapeutic recreation program. The swimming was supervised by college-aged instructors. Clients were from special education classes from the public schools or the sheltered workshop serving three counties. Data were obtained from 10 clients (5 male, 5 female) on two physical performance tasks, the stabilometer and the Shape-O-Ball, both at the outset and at the conclusion of the eight-week program.

Least squares analyses examined sex, trials (pre and post test), sex*trial interaction and client within sex. For contacts (number of times the balance bar touched the ground in twenty seconds), the overall mean was 19.2, R^2=.69, SE $\pm$ 3.78 and sex was statistically significant (P<.03); for balance (time client was in balance during 20 sec. trial) the the mean was 7.85, R^2=.77, SE $\pm$ .92 and differences among clients, within sex were significant (P<.04); and, for the Shape-O-Ball (time required to put puzzle together) the mean was 67.0, R^2=.90, SE $\pm$ 17.1 with these effects significant: sex (P<.01) with females 71.0 and males 63.0; trials (P<.01) with Trial 1 at 78.8 and Trial 2 at 55.2 and clients within sex (P<.01).

The program has been continued and, modified in part to reflect the finding from this study.

EFFECTS OF CLASSROOM ANIMALS ON VERBALIZATION. B. B. Goldstein*. Dept. of Educ., W'm & Mary, Williamsburg, Va. 23185

The effects of classroom pets on verbalization were studied in a Title I setting in which the children were characterized as almost non-verbal. A series of six creative stories by each child in the control and experimental groups were examined and compared quantitatively and qualitatively. The children in the experimental group were taught reading and language skills using classroom pets as a springboard and medium for learning. The children in the control group were not allowed to interact or converse about the animals in class.

The data showed some qualitative changes in the nature of the stories, but these changes cannot be attributed to the use or non-use of animals due to the extremely small number of changes observed. However, there was a definite positive relationship between the use of classroom animals and the length of story (.01 level of confidence) and the number of descriptors used (.05 level of confidence). The data collected supported the hypothesis that the use of animals in the classroom would cause increased quantity and quality of verbalizations when judged by the length of story and the number of descriptors. There were several interesting behavioral reactions displayed by individuals involved in the study. These reactions, although discussed only briefly in the study, lend further support to the value of classroom pets and continued study of this topic.

TEACHING BIOLOGY TO NON-SCIENCE MAJORS: THE OLD DOMINION PLAN. J. E. Browne and K. N. Nesius*, Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23508

Biology for non-science majors utilizes a modified version of the audio-tutorial methodology of Postlethwait. Various information delivery systems are used to attend to diverse backgrounds and differing cognitive styles. Computer managed diagnostic testing is utilized, with multiple testing opportunities. Comparisons are made between percentages of students at each mastery level for the present program and the traditional program. The average number of pre- and post-tests taken at each mastery level is analyzed and discussed.

MICROCOMPUTERS IN INSTRUCTION: A STATUS REPORT. R.L. Gull,* Supervisor, Courseware Development, Norfolk Public Schools, Norfolk, VA 23510

The microcomputer's processing power, memory capabilities, sound, color and graphics make it an extraordinary instructional tool. While the technology is capable, significant hurdles must be overcome before microcomputers will be accepted as an effective instructional supplement.

Two major problems exist, and corresponding suggestions are as follows:
- Lack of computer literacy skills by teaching personnel
  . develop a long range computer literacy inservice plan
  . bring in guest speakers with specialized skills
  . conduct guided equipment hands-on activities
  . allow for non guided equipment hands-on activities
  . make equipment available in laboratory sites, or on a sign out basis
  . visit existing microcomputer programs
- Lack of validated courseware (curriculum) for microcomputers
  . establish a process for formally evaluating courseware
  . request validation and/or field testing results
  . require a demonstration of courseware on the school's equipment
  . purchase courseware from an established reliable company.

SCIENCE TEACHERS PERCEPTIONS REGARDING POSSIBLE TASKS FOR PARAPROFESSIONALS IN SCIENCE EDUCATION. Alan Mandell. Department of Curriculum and Instruction, Old Dominion University, Norfolk, Va. 23705.

A questionnaire listing 24 possible tasks for paraprofessionals in secondary/middle school science teaching was administered to a sample of 32 science teachers to obtain their perceptions of appropriate tasks for such personnel.

The respondents were asked to check one of four columns labeled "Very Appropriate","Possibly Appropriate","Not Too Appropriate", and "Definitely Not Appropriate" for each task. The four columns were weighted and the mean rating and standard deviation for each task was computed. The list of tasks was then ranked on the basis of the mean ratings.

There was strong agreement in this sample that the 'professional' aspects of teaching such as lecturing, demonstrating, disciplining, and taking responsibilities were not appropriate for paraprofessionals. The more mundane tasks of assisting in laboratory activities, grading papers, operating audio-visual equipment, and maintaining bulletin boards were deemed appropriate.

Ninety-seven percent of the sample felt that a paraprofessional would be of assistance to their science department. Seventy-eight percent would like to have personal paraprofessional assistance.

EXPLORING BIOLOGICAL SCIENCES CURRICULUM STUDY AND NUFFIELD BIOLOGY. A.L. Mannarino, Dept. of Science, Smithfield High School, Smithfield, VA 23430

This study explores the similarities and differences in both BSCS and Nuffield Biology methods of teaching science through inquiry. Although BSCS and Nuffield Biology are similar in goals, they are vastly different in the approaches they take. For instance, BSCS combines the theory of biology with its practical application. It is the textbook rather than the teacher which dictates the structure of the curriculum. On the other hand, the Nuffield Biology method of inquiry utilizes the teacher as both the source of the theoretical information and the coordinator of the laboratory activities, whereas BSCS is somewhat rigid in structure. Nuffield is flexible enough to meet the teacher's objectives. BSCS provides an innovative approach with definite advantages over the previous texts and methods used in the United States. Nuffield Biology, the British counterpart, emphasizes the inquiry approach to a greater degree, pushing the student towards greater exposure to the scientific method of thought. Nuffield Biology achieves its goals through a five year sequential and developmental program of study, beginning at age eleven and carries it through to the age of sixteen. If the BSCS approach were to be extended beyond the confines of a single year of study, its goal as a method of scientific inquiry could be comparable to the Nuffield Biology concept.

A COURSE FOR SENIOR HIGH GIFTED STUDENTS: THE BAY, EXPLORE IT: AN ECOLOGICAL STUDY OF THE CHESAPEAKE BAY. L. W. McLAMB*, Old Donation Center for the Gifted and Talented, 1008 Ferry Plantation Rd., Va. Beach, VA 23455

A course for secondary gifted students focusing on the ecology of the Chesapeake Bay was developed at the Center for the Gifted during the Spring of 1980. Sixty-five students, from grades seven through twelve were involved in thirty-five hours of instruction. A variety of instructional strategies including Parnes' Creative Problem Solving Process, Taba's Inductive Teaching Model, and Schwab's Biological Science Inquiry Method were integrated into an activity-oriented instructional unit emphasizing student involvement in field investigations.

Formative and summative evaluation instruments were developed to assist in determining changes in student knowledge, effectiveness of instructional activities, and the effectiveness of the course in meeting stated objectives. Following analysis of the evaluation information, revisions were made and the course was offered during the Spring of 1981. In the Spring of 1982 the course will be included in the Virginia Beach City Public Schools curriculum as an elective credit offering for senior high gifted students.

Funding Assistance provided by the Citizens' Program for the Chesapeake Bay, Inc.

CURRENT TRENDS IN ENVIRONMENTAL EDUCATION. Teresa Myer, Science Service, Va.Dept. of Education, Richmond, Va. 23216

The basic aim of environmental education is to help individuals understand the complex nature of the natural and built environments; and to acquire the knowledge, attitudes, and skills to participate in a responsible and effective way in integrated environmental management.

There have been both problems and progress in achieving this goal. The difficulty in defining environmental education and its interdisciplinary nature has resulted in a lack of academic respectability and has presented a problem in finding space for it in the traditional curriculum. A great deal of time and effort has been spent in seeking leadership and funding from the federal government, but strong support was never forthcoming. Successes have more often been the result of grassroots movements of individuals and coalitions of agencies and organizations.

Virginia has several successful environmental education programs in local school divisions and has an association which assists in statewide communication. The Science Service of the Va. Dept. of Education is taking steps to help infuse environmental education into the science curriculum. Both in-service and pre-service teacher education continues. Inclusion of environmental/energy concepts is one criteria by which science textbooks are evaluated. Finally, several learner outcomes in the K-12 Standards of Learning Program for science deal with environmental education concepts.

MULTIPLE OPTIONS GRADING SYSTEM: CORE MATERIAL MASTERY INSTRUCTION AND PERSONALIZED EDUCATIONAL ARENAS. James P. O'Brien, Tidewater Community College, Virginia Beach, Virginia 23456.

If colleges and universities are to reify their goal of producing people who can think more clearly, more critically and more comprehensively; then professors must know how and when to practice the classical distinction between educator and instructor. The following model is explored: (1) identify the core material and require its mastery to count about one-third of the highest grade in the course; (2) set priorities on the remaining material, weigh these topics differentially, and let the student select among them, (3) consider the tools that are used in fields relevant to course material, and create and weigh opportunities that will encourage student practice with these tools; and (4) set deadlines, give clear instructions, and negotiate emergencies. Advantages: (1) competence rather than competition is graded; (2) more students earn higher grades; (3) the teacher effectively weds education and instruction; (4) the student is more likely to become self-educating; (5) teaching assistants are more likely to develop broader knowledge and skills. Disadvantages: (1) a slightly higher withdrawal rate; (2) more time required for grading; (3) more time required for initial preparation of materials and training of assistants; (4) extra anticipation of students' needs and anxieties requiring clarity and consideration. Examples of effects and course materials are presented.

THE SPIDER MUSEUM. LaVonne B. Schurman* Coordinator, Mathematics and Science Center, Richmond, Va. 23223

The Spider Museum, with its collection of objects and living arachnids from around the world, is dedicated to educating people about spiders and dispelling fears of people that most spiders are evil and harmful.

Visitors are made aware of: the usefulness of spiders in the environment; how man benefits from spiders; the lack of scientific knowledge of the arachnids; and the folk-lore and superstitions still surrounding the arachnids.

Students are encouraged to develop scientific investigations and activities relating to spiders, and are made aware of the many species of spiders. Spiders are found in all parts of the world and many species have never been classified, or so it is believed.

The daily logs and/or data on each of the twenty(20) or more live specimens can be used in the publication of articles dealing with the behavior and life patterns of different species.

THE USE OF RESEARCH REACTORS FOR EDUCATIONAL PROGRAMS IN SCIENCE. B. L. Shriver and P. E. Benneche*, Dept. of Nucl. Engr. & Engr. Physics, Univ. of Va., Charlottesville, VA. 22901.

The University of Virginia Reactor Facility is widely used to support educational programs in science at other universities and colleges in Virginia. This work is supported by the U. S. Department of Energy under the Reactor Sharing Program.

The University of Virginia Reactor Sharing Program consists of two parts. First, students from area colleges visit the Reactor Facility to perform experiments in radiation, radioactive decay, radioisotope applications in science and industry, and reactor experiments. Over 200 students from ten Virginia universities and colleges have participated in this program.

Secondly, the reactor and counting facilities are used to support research, primarily in the use of neutron activation analysis for analysis of environmental and biological samples. The majority of the research conducted under this program has been conducted by faculty and students from James Madison University departments of Biology and Physics. These projects have used neutron activation analysis to determine the composition of airborne particulates, measure long term uptake of pollutants by trees and the effects of cadmium in rats.

MARINE SCIENCE AT OLD DOMINION UNIVERSITY, AN OPPORTUNITY FOR SECONDARY SCHOOL GRADUATES. H. B. Stewart, Jr. Ctr. for Marine Studies, Old Dominion University, Norfolk, Va. 23508

Educational programs in marine science have taken on increased importance in Virginia universities as the public becomes more aware of and concerned about our abundant marine resources. Critical to the effective management of these resources is a better understanding of the resources themselves and of the complex estuarine and nearshore oceanic environments in which they are found.

Old Dominion University with its expanding program in marine science education and research provides an opportunity for the serious secondary school senior with a marine science career in mind. For the university graduate, the freshman with oceanographic interests is encouraged to investigate the various physical and life science that constitute the science of oceanography: physics, biology, chemistry, and geology with a view towards majoring in one of these basic science fields. An undergraduate course in general oceanography is available, and a newly instituted program of a minor in marine science is available to the student majoring in one of the basic sciences.

A graduate program leading to the MS and PhD degrees in oceanography is conducted by the Department of Oceanography with concentrations in the fields of biological, chemical, geological, and physical oceanography. In the 1980-81 school year, there were 109 graduate students enrolled in the Department of Oceanography. Counselors are encouraged to contact ODU.

Engineering

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University

SEASONAL COLLECTION AND STORAGE OF SOLAR ENERGY BY COVERED POOLS. J. T. Beard, L. U. Lilleleht, and F. A. Iachetta, School of Engineering and Applied Sciences, Univ. of Va, Charlottesville, VA 22901

The concept of seasonal collection of solar energy and storage in a covered pool of water has been analyzed with the aid of a digital computer simulation program. Parts of the model were validated by successfully simulating the thermal performance of a prototype collection/storage system sized for a single-family residence in central Virginia. The experimental system consisted of a 104 m^3 pool covered with 53.5 m^2 nearly horizontal trickle-type collectors.

As the prototype system turned out to be inadequate for the intended service, a number of design modifications were investigated through computer simulation. These included increased energy collection, reduced heat losses, and the use of a water-source heat pump rather than direct heating with the pool water.

The results show that the fraction of the heat load for a single-family residence deliverable by the seasonal collection/storage system increases significantly with the various design modifications and can be made to approach unity.

Life cycle costs are presented for the prototype pool system along with comparisons with those for the various design modifications in terms of annualized costs.

INVESTIGATION OF A SPECIAL PASSIVE THERMAL SIPHON CONCEPT FOR THE REDUCTION OF COOLING LOADS. J. W. Dille*, Brown Shoe Company, St. Louis, MO 63131, and J. T. Beard, Dept of Mechanical and Aerospace Engineering, University of Va., Charlottesville, VA 22901

The University of Va. and the U. S. Dept. of Agriculture Stored Tobacco Insects Lab. have been engaged in research to develop a cooling system for controlling insect growth in stored tobacco. In an effort to reduce cooling loads, a solar driven thermal siphon has been evaluated through the use of a computer program which simulates the flow between the two parallel vertical walls. The outside wall is exposed to the sun, and the inner wall is an insulated surface. The air channel between the two walls is vented at the top and bottom, allowing ambient air to flow through and thereby remove a large portion of the solar gain of the building.

The analytical problem involves fluid dynamics, both forced and free convection heat transfer, bouyant driving forces, and radiation and conduction heat transfer.

This paper describes the results of the simulation with recommendations for the channel width and insulation thickness on the inside wall and with indications of the expected reduction which would occur in building cooling loads.

DESIGN OF CAPSULES FOR IRRADIATION OF REACTOR PRESSURE VESSEL STEELS IN THE UNIVERSITY OF VIRGINIA REACTOR. C. A. Bly*, J. L. Kelly* and B. L. Shriver. Dept. of Nucl. Engr. & Engr. Phys., Univ. of Va., Charlottesville, VA 22901.

An irradiation capsule has been designed that allows precise determination and control of the radiation flux and specimen temperature during irradiation. The volume of the specimen region of the capsule is about 60 cm^3. The use of well-machined metal surfaces, radiation-tolerant sealants, and screw fastenings in the construction of the capsule has ensured that it is reuseable. Capsule cooling is achieved by diverting 1.0% of the primary coolant flow of the Univ. of Va. Nuclear Reactor through the flow-channel containing the experiment. Boral is included in the capsule structure to reduce thermal neutron activation of the material specimens.

Design calculations involved coupled analyses of radiation attenuation and its attendant heating, additional heating supplied by resistance heaters, and heat transfer and fluid flow which apply to the capsule geometry.

A "dummy" capsule was designed, fabricated, and tested to assure that all design criteria were satisfied. This capsule program met the design objectives, and presently we are involved with the fabrication and testing of the first generation of test capsules.

The test capsule design can serve as a phototype design of single fuel-element sized irradiation capsules that can be used at all nuclear research facilities during standard M.T.R. type fuel elements.

AN ANALYTICAL MODEL OF THE ICE ACCRETION PROCESS. R.D. Kirchner. Institute for Hypersonic Studies, Inc., 7602 Cornwall Road, Richmond, Va. 23229.- Currently on active duty in the U.S. Air Force.

Today many civilian and military aircraft lack the necessary de-icing or anti-icing capabilities to allow safe/successful operation during icing conditions. The present investigation attempted to establish a time dependent numerical solution of the ice accretion process that could predict the extent of icing under all icing conditions. A computer simulation of the icing process was developed for test cases involving a 2.54 cm in diameter circular cylinder with both rime and glaze icing conditions. A Lagrangian approach was used to establish impact locations for individual water droplets; and the equilibrium heat transfer condition was established along the surface to determine the extent of icing. Variations and effects of surface roughness were incorporated into the convective and evaporative heat transfer relationships, and the ice density was allowed to vary as a function of the droplet impact velocity and the surface temperature. Predictions of the icing patterns were found to be in favorable agreement with experimental results when using a heat transfer relationship that was extrapolated from experimental heat transfer data on a roughened cylinder.

SENSOR-ERROR RELATIONSHIPS FOR MACHINE VISION MENSURATION.
E. S. McVey*. Dept. of Electrical Engineering, Univ, of Va.
22901
    Machine vision is becoming an important technology for
advanced automation and instrumentation. It can provide a
visual input to many kinds of systems for applications such
as material handling, medical analysis and robotics. The
ability to make distance and dimension measurements will ex-
pand even further the potential of machine vision. To make
measurements, it is necessary to establish relationships
between object space and the vision sensor geometry. This
can be accomplished in terms of sensor array size and
measurement accuracy.

IODINE PARTITION COEFFICIENT AT LOW CONCENTRATIONS IN PURE
WATER. R. U. Mulder*, C. J. Babao*, and J. L. Kelly* Dept. of
Nucl. & Engr. Physics, Univ. of Va., Charlottesville,
Va. 22901.
    The study of iodine chemistry and iodine partition coef-
ficients at low aqueous concentrations was begun some twenty
years ago. As part of that effort, a theoretical model pre-
dicting iodine partition coefficients was developed by A.E.
J. Eggleton. Other workers provided some experimental
checks at scattered values of pH, temperature, and iodine
concentration. These early results indicated that Eggleton's
model represented a conservative estimate of iodine parti-
tion coefficient values (i.e., predicted values lower than
actual values). Since the Three Mile Island incident, there
has been a renewed interest in realistic evaluations of the
radioiodine source terms. In light of this interest, our
work was undertaken to evaluate the iodine partition coeffi-
cient over the following range of conditions in pure water:
T=30, 50, 70C; pH = 5, 7, 9; iodine aqueous-phase concentra-
tions = 10^{-4} to 10^{-10} g/cc.
    Our experimental results conform to Eggleton's model for
aqueous iodine concentrations in excess of about 10^{-6} g/cc.
However, for all conditions examined, the experimental par-
tition coefficient approaches a fairly constant value of
1000 at very low concentrations. This is in sharp contrast
with Eggleton's theory, and is explainable in terms of HIO
volatility. Also, the value of the partition coefficient is
quite sensitive to the presence of impurities.

THE IMPACT OF TREATED SEWAGE EFFLUENT AND STORMWATER RUNOFF
ON THE ALGAL GROWTH POTENTIAL OF THE OCCOQUAN RESERVOIR.
K. G. Saunders* and T. J. Grizzard*. Occoquan Watershed
Monitoring Lab., Va. Polytechnic Inst., Manassas, Va. 22110
    During the period July 1978-December 1979, algal growth
potential studies were conducted on Occoquan Reservoir
waters using a modified bottle test. Productivity in the
reservoir varied from low to high (0.0-29.3 mg/1 dry weight)
during the study period. Ortho-phosphorus concentrations
varied concurrently (0.00-0.12 mg/1). Over 90% of the
samples were phosphorus limited. Phosphorus enters the res-
ervoir system in treated sewage effluent and stormwater run-
off. Productivity was consistently high during and follow-
ing periods of storm runoff. Superior phosphorus control in
the new advanced wastewater treatment plant limited the
algal growth potential of the reservoir during low flow pe-
riods.

HYBRID THERMOELECTRIC SOLAR COLLECTOR DESIGN AND ANALYSIS.
K. Shaheen* and A. S. Roberts, Jr.* Dept. of Mechanical
Engr. and Mechanics, Old Dominion Univ., Norfolk, Va. 23508
    A flat-plate solar collector is conceived which would
provide DC electric power while energy is transferred from
the absorber plate to the heat transfer fluid. The work re-
ported here represents a preliminary design study which
involved the steady-state modelling of the collector and a
parametric study of thermodynamic performance. Thermo-
electric modules are imbedded in the absorber surface over a
parallel array of vertical tubes connected by inlet and exit
headers; energy cascades through the modules before being
convected away. Electric power produced can be utilized to
drive pumps, fans and controllers. The results of this para-
metric study, if favorable, will be used for experiment
design and preliminary economic analysis of "stand-alone"
solar collector arrays. (Partial support by NASA Langley
Res. Ctr.).

BENEFITS OF HAVING UNDERGRADUATE STUDENTS PARTICIPATE IN THE
OPERATION OF ENGINEERING RESEARCH FACILITIES. Bryce L.Shriver
Dept. of Nucl. Engr. & Engr. Phys., Univ. of Va., Charlottes-
ville, VA 22901
    The need for including practical experience in undergradu-
ate engineering programs has long been known. One method for
achieving this is by having students work in research facili-
ties operated by engineering schools, such as research reac-
tors.
    One specific case, the training of undergraduate students
to operate the Univ. of Va. Research Reactor, has been re-
viewed. Since 1979 over 40 students have been licensed by
the Nucl. Reg. Comm. to operate the Univ. of Va. Reactor.
    A survey of nuclear engineering students was performed to
provide information concerning the benefits of the training
program. Both reactor operators and non operators considered
that the training program was beneficial in each of the ten
areas surveyed. As expected the educational areas most en-
hanced were those emphasized by the training program and sub-
sequent work experience, such as reactor operation, reactor
systems, and nuclear instrumentation.
    In addition it appears that the availability of this trai-
ning program is a significant factor in the student's deci-
sion to major in nuclear engineering. In addition the gradu-
ate enrollment is significantly higher than that of non-oper-
ators as shown by the fraction of reactor operators who en-
roll in graduate school (54%) as compared to that for non-
operators (31%).

OPTIMIZATION OF A SOLAR SOURCE HEAT PUMP FOR RESIDENTIAL
SPACE HEATING. J. J. Tandler* and M. R. Sexton, School of
Engineering and Applied Science, University of Virginia,
Charlottesville, VA 22901
    A solar source heat pump heating system design was opti-
mized to provide lowest annual cost. A liquid collector,
water tank storage system was simulated using the TRNSYS
computer program. Thermal performance results from the
TRNSYS program were used in a second computer program to
optimize the system for lowest annual cost. Heat pumps
designed for the higher evaporator temperatures resulting
from solar source applications were considered. Results
showed that high collector efficiency does not necessarily
mean better system performance, and that annual cost was
not a strong function of storage volume.

NASA/HAMPTON REFUSE FIRED STEAM PLANT: A SMALL SCALE
FACILITY WITH LARGE SCALE TECHNOLOGY. Hunter F. Taylor,PE
Charles R. Velzy Associates, Inc., Richmond, Virginia
    The most recent solid waste processing facility in the
U.S. started up in Hampton, Virginia in September, 1980.
The plant utilizes "mass-firing" to burn 200 tons/day of
unprepared municipal solid waste from the City of Hampton
and supply steam at 360 psig. to NASA-Langley Research
Center. The process comprises two 100 TPD waterwall fur-
naces with integral boilers, reciprocating grate stokers,
electrostatic precipitators, and state-of-the-art analog
controls for automatic operation of the boilers. The
$10.4 million facility is of particular interest for several
reasons:
    1. It is a joint venture between a federal agency seek-
ing to decrease its consumption of fuel oil and a coastal
city seeking an alternative to landfill disposal.
    2. The process design emphasizes steam plant technol-
ogy for solid fuels rather than disposal technology for
solid wastes.
    3. It uses limited source separation to minimize fuel-
ing handling costs and outages due to bulky items while
eliminating the need for shredding.
    4. It is intended to demonstrate the feasibility of
utilizing waterwall furnace/integral boiler technology for
MSW throughput of only 100 TPD. (It is the smallest plant
of this type).

Environmental Science

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OPEN OCEAN DISPOSAL OF DREDGED MATERIALS: A BIOLOGICAL ASSESSMENT OF SPOILS FROM THE PORT OF HAMPTON ROADS. R. W. Alden. Dept. of Biological Sciences, Old Dominion Univ., Norfolk, Va. 23508

A study was conducted to determine the potential biological impact of open ocean disposal of spoils dredged from the Port of Hampton Roads, Virginia, a highly industrialized seaport system. Spoil fractions of sediments from a number of potential dredge sites were tested through a series of lethal and sublethal bioassay experiments with the grass shrimp Palaemonetes pugio. Dissolved and suspended materials which would be released during disposal operations did not produce significant lethal effects for most of the sites tested. However, rapid lethal effects were observed during the suspended solid phase experiments for a few of the most highly industrialized sites. Significant depression in respiration rates was noted for shrimp surviving exposure to elutriates of sediments from these sites. Exposure of the shrimp to the heaviest fraction of the spoils produced moderately low mortalities throughout all ten day experiments. Iron, manganese and zinc were the only metals to accumulate significantly in the shrimp during these experiments.

These preliminary findings indicate that much of the sediments from Hampton Roads is of adequate quality for open ocean disposal, although current and pending investigations have been designed to examine various aspects of this topic in greater detail.

HYDRAULIC MODEL INVESTIGATION OF POLLUTANT SPREADING AROUND MARINAS. Carvel Blair, Dept. of Oceanography, Old Dominion University, Norfolk, VA 23508

A properly adjusted Froude model reproduces accurately some of the physical phenomena in an estuary. Other phenomena are distorted. In the case of mixing of dissolved pollutants, existence of similtude depends upon which phenomena, if any, dominate the mass transfer process. Assisted by a Sea Grant, ODU is investigating how to use the Corps of Engineers' Chesapeake Bay Model to predict the temporal and spatial spread of pollutants in the vicinity of marinas. In those locations in which similtude exists, model data can help establish shellfish barrier zones in the prototype.

Prototype dye tracer experiments have been conducted in the Lafayette River and (through a cooperative investigation at the Virginia Institute of Marine Science) in Green Mansion Cove off Mobjack Bay. Preliminary model tests have verified the prototype Lafayette River data. Work has been delayed by damage to the model, but will resume in summer 1981. The effect of freshwater discharge will receive special attention.

AMBIENT AMMONIA MEASUREMENTS USING LASER PHOTO-ACOUSTIC SPECTROSCOPY. M.D. Aldridge III*, G. E. Copeland, C.N. Harward. Department of Physics, Old Dominion University, Norfolk, VA , 23508.

Measurements of gaseous atmospheric ammonia from September 1980 to mid-March 1981 were obtained with an experimental system employing laser photo-acoustic spectroscopic techniques. Ammonia concentrations reached minimal levels (approximately 0.1 ppb) in early winter, followed by a sudden late winter increase. A direct relationship between ambient ammonia levels and air temperature was inferred from the data (linear correlation coefficient r = 0.53). Ammonia concentrations were determined to be directly related to the absolute humidity of the air (r = 0.72); a weaker relationship between ammonia concentrations and relative humidity was discovered (r = 0.37). The data also indicated that ammonia levels were generally higher within continental air masses than those of maritime origin. Soil parameters such as pH and moisture content were found to have a major bearing on the release of gaseous ammonia from soils in the region.

MODELING OF TRACE METALS IN THE ATMOSPHERE. L. L. Brooks*. Dept. of Geophysical Sciences, Old Dominion University, Norfolk, Va. 23508

The behavior of trace metals in the atmosphere is a relatively unknown science. Sources of the metals come from both natural and anthroprogenic categories. The use of coal, an important source of trace metals will rise substantially as the United States strives to become energy self sufficient. The combustion process of coal will enrich certain metals in the flue gases. Particle size seems to be one of the most important parameters and trace metals appear to be divided into three size groups - 0.54, 4.0, and 11.0 micrometers. The particles follow the normal log distribution. The removal of metal particles is done by two processes, wet and dry deposition. Analysis of these particles can probably best be accomplished by neutron activation, but the most cost efficient analysis would be atomic absorption spectrophotometry. Analysis of particles has shown a wide variability of individual metal concentration without regard to total mass collected. Modeling of metals in the atmosphere using principal components analysis has great promise since the model would enable geographic regions to be identified not only by amounts of particles but also by the metal concentrations in the particles.

COPROSTANOL AS A POTENTIAL TRACER OF PARTICULATE SEWAGE EF-
FLUENTS. R.C. Brown and T.L. Wade , Dept. of Oceanography,
Old Dominion University, Norfolk, Va. 23508
    A total of 66 samples, collected in the Chesapeake Bay
entrance and adjacent shelf waters, were analyzed for par-
ticulate coprostanol concentration. Coprostanol, an indi-
cator of fecal contamination, may originate in these waters
from the discharge of sewage treatment plant effluent, land
run off, or direct discharge from ships in the area. Sur-
face coprostanol concentrations were fairly uniform, with a
slight increase with depth. This increase with depth may be
due to sewage associated particulates settling as they
leave the bay, or the resuspension of contaminated sediment.
Preliminary indications are that sewage associated materials
are being transported from the Chesapeake Bay to shelf wa-
ters, where they may have a detrimental affect on living
marine resources.

CHARACTERISTICS OF THE TURBID QUALITY OF WATER AT THE EN-
TRANCE TO CHESAPEAKE BAY AND IN NEARSHORE WATERS OF THE
CENTRAL VIRGINIA EMBAYMENT. M.R. BYRNES*, K.J. Gingerich*,
and G.F. Oertel. Dept. of Oceanography, Old Dominion
University, Norfolk, VA 23508.
    The characteristics and distribution of total suspended
particulates at the mouth of Chesapeake Bay and in coastal
waters off Virginia Beach illustrated three apparent source
areas. Suspended material assemblages were associated with:
1) runoff, 2) resuspension of material within the Bay,
and/or 3) resuspension of material over shoals and in re-
gions adjacent to the coast. Since "near drought" condi-
tions existed for several months prior to the survey, re-
suspension due to wave and current action was a major source
of turbidity.
    Cross-sectional plots of total suspended matter illus-
trated the three areas characterized by different resuspen-
sion processes. Regions adjacent to the coast of Virginia
Beach showed two distinct areas characterized by turbid
water; a surface "turbid plume" associated with resuspension
and dispersion of material by currents and a near-bottom
"turbid layer" associated with resuspension by waves and
minimal dispersion by currents. The outwelling of Chesa-
peake Bay water was also characterized by high turbidity.
This was associated with suspension of particles over
shoals in the northern Bay mouth and subsequent transport
of material in a southeasterly direction.

SCALE EFFECTS OF HYDRAULIC MODELLING OF BUOYANT FREE SURFACE
THERMAL PLUMES. Li-Cheng Chu*, and John M. Kuhlman, ODU,
Norfolk, VA 23508
    Small scale hydraulic modelling of a buoyant thermal
plume in a crossflow is essential to the accurate pre-
diction of mean thermal plume size and trajectory, since
field studies are usually too costly and uncontrollable,
and since the theoretical models are somewhat unreliable
as predictive tools. In the present work, a 5 m square
hydraulic flume has been utilized to obtain mean plume
size and trajectory data, using thermocouples and dye
injection, for a range of jet-to-crossflow velocity
ratios, Reynolds numbers, and a range of jet internal
Froude numbers (ie, various jet-to-crossflow tempera-
ture differences).
    Computer generated three-D mean plume isotherm contours
indicate the existence of a weak vortex structure in the
upstream side of the plume. Dye and thermal measure-
ments of mean plume width and trajectory indicate a large
effect of Reynolds number on mean plume characteristics,
while turbulence generating grids placed in the crossflow
or jet channels have little effect on the plume. Thus,
scale effects due to lack of dynamic similiarity (model
Reynolds number too small) appear to be too large to
allow using laboratory thermal plume data directly on a
predictive basis. However, lab data should be of great
value in improving theoretical plume models. (Aided by
NSF grant ENG-78-00815).

A PRELIMINARY STUDY ON THE INGESTION OF DETRITAL MATERIAL
BY PALAEMONETES PUGIO, USING ^{14}C RADIOLABELING METHODS.
M. P. Crosby*, L. Wolfinbarger, Jr., and R. W. Alden, III.
Dept. of Biological Sciences, Old Dominion Univ., Norfolk,
VA. 23508
    A new procedure for radiolabeling detrital particles is
presented. The methodology involves methylation of
detrital material (90-125 μ) with ^{14}C dimethyl-sulfate in
an alkaline media and requires less than two hours to
perform. The formed covalent bond is stable over time at
0°C and to acid hydrolysis.
    A preliminary feeding study was conducted to determine
if P. pugio is able to utilize the labelled detrital
material. Serial sampling of P. pugio was conducted during
a 24 hour feeding. Results of the whole body liquid
scintillation (LS) counting assay indicated differences in
uptake of the detritus by different size ranges of shrimp
and a general increase in CPM's in the shrimp over the
duration of the study. Implications of these results on
future studies are discussed.

VARIABILITY IN THE TURBID QUALITY CHARACTERISTICS OF WATER
IN THE CHESAPEAKE BAY ENTRANCE AND RELATIONSHIPS WITH WATER
MASS BOUNDARY CONDITIONS. K.J. Gingerich*, M.R. Byrnes*,
and G.F. Oertel. Dept. of Oceanography, Old Dominion
University, Norfolk, VA 23508.
    In the mouth of Chesapeake Bay, water mass boundary
conditions illustrated a variety of characteristics. Two
types of estuarine fronts were observed in the entrance to
Chesapeake Bay. The first type of frontal feature was
apparently controlled by tidal currents and bathymetry.
Strong turbidity gradients across these fronts were primar-
ily affected by variations in total suspended matter con-
centration. The average variation across the frontal
boundary, based on the analyses of six fronts, was 13 mg/ℓ.
The magnitude of shear, surface convergence, and surface
roughness was apparently related to relative speeds of
tidal currents around shoals and channels. A second type
of estuarine front was maintained by bathymetry, as well
as pronounced salinity gradients (.02 to .08 o/oo per
meter, horizontally).
    High turbidity water was confined to shallow margins
of fronts rather than in channels. In general, the out-
welling of Bay water through numerous channels illustrated
lower turbidity than shallow water over entrance shoals.

COHERENCE BETWEEN WIND AND CURRENT EVENTS IN A
NEARSHORE, SHALLOW WATER, WAVE DOMINATED ENVIRON-
MENT. G.M.Hecker. Department of Oceanography, Old
Dominion Univ., Norfolk, Va. 23508
    Five days of observations were made of the cur-
rent at 4 depths in a water depth of 8 m.,and an
accompanying record of local wind, 0.5 Km offshore
at Duck, N. Carolina, beginning 5 May, 1978. The
current was measured with an electromagnetic curr-
ent meter having a 0.2-sec. response and ±2 cm/sec
accuracy. At each depth a 10-min. record was made
each hour with a sampling interval of 1/8-th sec.
The frequency components of the record were ana-
lyzed and found to be essentially free from noise
and bias. The record of 120 ten-min. averages was
also analyzed for components. Semidiurnal and di-
urnal components and quadratic curve trends were
identified. Analysis by fast Fourier transform re-
vealed that the component of the wind perpendicu-
lar to the coast had significant coherence with
the alongshore component of the current.

AN ANALYSIS OF METHODOLOGIES FOR ESTABLISHING PRIORITIES FOR USE OF CHESAPEAKE BAY WATERS. Waldon R. Kerns. Water Resources Research Center, Va. Polytechnic Inst. and State University, Blacksburg, Va. 24061
One objective of the resource allocation process is to gain efficiency in use of scarce resources by allocating them to the highest valued use. This paper provides a brief state-of-the-art review and evaluation of approaches to place a value on the varied and conflicting uses of an area's water resources. Focus is placed on water quality as an example of the potential application of the relationships between water quality parameters and alternative uses of the waters as a means to establish use valuation as a guide to resource allocation decisions.

ALTERNATIVE STRATEGIES FOR IMPLEMENTATION OF AREAWIDE WATER QUALITY PROGRAMS. Waldon R. Kerns. Water Resources Research Center, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061
A critical issue facing resource managers and "decision makers" with respect to managing nonpoint pollution is whether the direct regulatory approach is an efficient and equitable means of achieving goals. Economists and others including the legal profession are now advocating consideration of institutional changes to the system of management. This paper evaluates the use of alternative strategies including but not limited to bargaining, threat of litigation, economic incentives, tax systems, system of marketable rights, and residual charges. A distinction is made between strategies for management of traditional types of pollutants and the control of highly dangerous substances where risks are difficult to guage.

THE CHEMICAL COMPOSITION OF PRECIPITATION IN THE LOWER CHESAPEAKE BAY. J. I. Kiss* & G. T. F. Wong*. Dept. of Oceanography, Old Dominion Univ. Norfolk, Va. 23508
Samples of rainfall were collected from individual rain events over a six month period at four locations adjacent to the Chesapeake Bay (Norfolk, Gloucester Point, Kilmarnock and Cedar View), and analyzed for pH and nutrients. The values of pH ranged from 3.3 to 4.6. Lower values were observed at Norfolk and Gloucester Point. The concentration of reactive phosphate and total phosphorus varied from 2.6 and 2.2μM respectively to undetectable. Organic phosphorus constituted a significant fraction of phosphorus in some instances. The concentration of nitrite ranged from 0.34 μM to undetectable and ammonia concentrations fluctuated between 89.7 and 4.5μM.

A COMPARISON OF THE INITIAL DATA USED BY THE FLEET NUMERICAL OCEANOGRAPHIC CENTER AND THE NATIONAL WEATHER SERVICE UTILIZING A BAROTROPIC PRIMITIVE EQUATION (PE) MODEL. J. V. Koziana*, and J. D. Lambeth*. Old Dominion University, Norfolk, Va. 23508
Initial data is an important part in the accuracy of a forecast of a numerical model. A comparison is made of the initial data used by the Fleet Numerical Oceanographic Center (FNOC) and the National Weather Service (NWS). The major differences between the two data fields are the FNOC data incorporates satellite data over water in the determination of the pressure height field at 300 milibars and there are additional station observations over the ocean areas in the FNOC data. The pressure height field data used is over the Pacific Ocean and Western United States during May 1979 and is compared utilizing a barotropic primitive equation model. A comparison of the two forecasts to the actual occurance is done by using a S2 skill score. A subjective comparison is also made by synopticians who evaluate the two forecasts. (Funded by NASA LarC grant NCC1-34)

FRACTIONATION OF DISSOLVED ORGANIC CARBON IN ESTUARINE WATER AND SEAWATER. T.J. Oatts, Jr., G.T.F. Wong*. Dept. of Oceanography, Old Dominion University, Norfolk, VA 23508

Dissolved organic matter (DOM) in estuarine water and seawater was fractionated by conventional filtration through a glass fiber filter and then by ultrafiltration. Fractions containing total DOM and DOM with nominal molecular weights of $< 10^3$, $< 10^4$, $< 3 \times 10^4$ and $< 10^5$ were obtained and the concentrations of dissolved organic carbon (DOC) were measured. Estuarine water had a higher concentration of total DOC and a higher percentage of the DOC was in the fractions with higher molecular weight. The majority of the DOC in seawater was found in the fraction with molecular weights below 10^3.

REMOTELY SENSED WATER TURBIDITY CHARACTERISTICS OF THE NEAR-SHORE GEORGIA EMBAYMENT AND RELATIONSHIPS WITH ESTUARINE DYNAMICS, G.F. Oertel and G. August*, Dept. of Oceanography, Old Dominion University, Norfolk, VA 23508.
The areal extent of inlet associated turbid plumes and their relationship with tidal stage was determined using optical density measurements of bands 4 & 5 of LANDSAT images.
The shapes of density anomalies associated with inlets changed with the tide. Anomalies imaged during low tide exhibited well-rounded boundaries, whereas those imaged during high tide were smaller and had cerrated boundaries. The density anomalies associated with inlets were thought to be associated with turbid plumes from terrestrial runoff, however, a part of the turbidity was apparently associated with the resuspension of fine-grained particles from the seabed.
High tide plumes had the same areal extent as the corresponding ebb deltas, never varying by more than an order of magnitude. Low tide plumes were much larger and varied from the sizes of the corresponding ebb delta to greater than twice the size of the ebb delta.
If the turbid anomalies were indicators of the distributions of the water that had drained tidal lagoons, then the turbid water of the drained lagoon was generally restricted to the upper 0.5 to 2.0 m of water. Field measurements of temperature, salinity, and suspended solids illustrated that the outflow from many of the inlets was homopycnal, and that a significant portion of the optical anomalies thought to be turbid outflow plumes were produced by the resuspension of fine-grained particles.

THE INFLUENCE OF FRONTAL MECHANICS ON THE VARIABILITY OF HYDROCARBON CONCENTRATIONS IN THE ENTRANCE TO THE CHESAPEAKE BAY, G.F. Oertel, D.J. Velinsky, and T.L. Wade, Dept. of Oceanography, Old Dominion University, Norfolk, VA.

Concentrations of hydrocarbons in the entrance to Chesapeake Bay illustrate significant temporal and spatial variabilities. In general, concentrations in the bay mouth ranged from 4-14µg hydrocarbons per mg suspended matter, whereas seaward of the entrance concentrations ranged from 1-2µg/mg. Concentrations were higher in areas of resuspension and at the boundary between "outwelling" bay water and shelf water. In the Chesapeake Bay entrance concentrations of particulate hydrocarbons were 2.5 to 3.0 times greater in the summer of 1980 than in winter of 1981. In January 1981 observations at water mass boundaries within the bay entrance illustrated significant enrichment in concentration of particulate hydrocarbons, at frontal interfaces.

A preliminary descriptive model of the Chesapeake Bay entrance illustrates that convergent frontal systems and areas susceptible to resuspension by waves and currents, can maintain relatively high concentrations of particulate hydrocarbons.

MONITORING RESPONSE TO A MAJOR KEROSENE SPILL IN THE OCCOQUAN WATERSHED. S. M. Ortel*, B. L. Weand and T. J. Grizzard*. Occoquan Lab., Va. Tech., Manassas, Va. 22110

During March, 1980, a 32-inch refined petroleum pipeline traversing the Occoquan Watershed burst. Within a short time, approximately 326,000 gallons of kerosene had spilled into a tributary of the Occoquan Reservoir, threatening the water supply of nearly 700,000 users in the Washington, D.C. metropolitan area. During the following weeks a major effort was made by federal, state and local governments and by the pipeline company, to contain the spill, remove the product from both land and water, and to ensure the safety of the public water supply.

During the crisis, staff of the Occoquan Watershed Monitoring Laboratory (OWML) helped to establish an emergency water quality monitoring plan and to develop response protocols based upon levels of contaminant measured at the water supply intakes. Analyses used to track the contaminant in the reservoir included odor, total fluoroscing organics and total chromatographicable organics. The contaminant eventually reached the raw water intakes, and powdered activated carbon was then employed in the treatment processing scheme. No kerosene was ever detected in the finished water.

SPATIAL DISTRIBUTION OF HEAVY METALS IN SEDIMENTS FROM HAMPTON ROADS, CHESAPEAKE BAY, AND THE INNER VIRGINIAN SHELF. Joseph H. Rule, Department of Geophysical Sciences, Old Dominion University, Norfolk, Virginia 23508.

Selected heavy metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, and Zn) were measured on acid extracts of sediment samples from the Elizabeth River, Hampton Roads Harbor, Thimble Shoals and Cape Henry Shipping Channels and the proposed Norfolk Disposal Site for dredged sediments. Metal levels were lowest in the Norfolk Disposal Site sediments and increased in samples taken from the Chesapeake Bay shipping channels, Hampton Roads Harbor, and the Elizabeth River, in this order. Samples from the upper part of the Southern Branch of the Elizabeth River contained lower levels of metals than the more highly industrialized lower reaches. The distribution of most metals were described by a log-normal function. Cumulative frequency plots indicated two populations exist for most metals. The technique of metal vs. Fe plots was used to delineate sediments with natural metal levels from those affected by anthropogenic sources.
(Aided by NOAA Grant NA79AA-D-00026)

USE OF A BLOOD ENZYME AS AN INDICATOR OF CHRONIC LEAD CONTAMINATION IN RAINBOW TROUT. G. J. Sandone* and J. J. Ney. Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061.

In humans, the enzyme delta-amino levulinic acid dehydratase (ALA-D) is inhibited in the pathway of heme synthesis by lead. It has been suggested that determination of ALA-D activity might be a useful technique to define chronic lead contamination in a variety of vertebrates, including fish. We tested this hypothesis by comparing ALA-D activity in rainbow trout from two pristine and two lead-contaminated streams. Highways served as sources of contamination; previous research in this laboratory has documented the relationship of highway usage and heavy metals concentrations in stream biota.

Trout were sampled quarterly from each of the four streams, and ALA-D levels were compared. Results indicate that ALA-D activity varied significantly among streams and sampling dates and was inversely related to fish length. Trout taken from one pristine stream exhibited the lowest levels of enzyme activity, and ALA-D activity was highest in the roadside streams. Results are directly opposed to the hypothesis.

FACTORS AFFECTING THE VEGETATIVE RECOVERY OF A DEBRIS AVALANCHE IN NELSON COUNTY, VIRGINIA. Rebecca Schneider* Nina Fisher*, and Judith Peatross*. Department of Environmental Sciences, Univ. of Virginia, Charlottesville, VA. 22903

In August 1969, Hurricane Camille inundated Nelson County Virginia with 28 inches of rain in an 8 hour period. The associated floods resulted in hundreds of debris avalanches which cleared sections of slopes down to bedrock. Revegetation and soil development over the past 12 years differs markedly between various sites as well as within a single debris avalanche slope. Recovery covers a spectrum of micro environments from lichen and moss on exposed rock faces to dense tree stands on a thick soil substrate.

This study examines the factors which have controlled recovery on a single debris avalanche above Davis Creek, Nelson County. Physical influences including slope angle, soil depth and presence of boulders or fractures, were examined in each of 104 one square meter quadrats. Extent of recovery was established by measuring vegetative growth.

Multiple regression techniques were used to determine which factors contribute to the rapid recovery of the debris avalanche. Important features appear to include the relationship of the site to capture and retain soil. These factors facilitate the revegetative processes on a debris avalanche.

SENSITIVITY ANALYSIS OF UPWELLING THERMAL RADIANCE IN PRESENCE OF CLOUDS. S.V. Subramanian* and S.N. Tiwari, Dept. of Mech. Eng. and Mechanics, Old Dominion University, Norfolk, VA 23508, and J.T. Suttles*, NASA Langley Research Center, Hampton, VA 23665

Total upwelling radiance at the top of the atmosphere is evaluated theoritically in the presence of clouds. The influence of cloud heights, thicknesses and different cloud covers on the upwelling radiance is also investigated. The characteristics of the two cloud types considered in this study closely correspond to altocumulus and cirrus with the cloud emissivity as a function of its liquid water (or ice) content. For calculation of the integrated transmittance of atmospheric gases such as, H_2O, CO_2, O_3, and N_2O, the Quasi Random Band (QRB) model approach is adopted. Results are obtained in three different spectral ranges and are compared with the clearsky radiance results. It is found that the difference between the clearsky and cloudy radiance increases with increasing cloud height and liquid water content. This difference also decreases as the surface temperature approaches the value of the cloud top temperature.

THE DISTRIBUTION OF IODATE IN THE JAMES RIVER AND THE LOWER CHESAPEAKE BAY. K. Takayanagi and G.T.F. Wong*, Dept. Of Oceanography, Old Dominion University, Norfolk, VA 23508.

Salinities and the concentrations of iodate were measured in surface waters of the James River and the southern Chesapeake Bay. Concentrations of iodate ranged from below detection limit to 0.241 μM with salinities 0 to 32.7 o/oo, respectively. Although the concentration of iodate, in general, increased with increasing salinity, a linear relationship has not observed. The observed concentrations fell below the theoretical mixing line of a conservative tracer between river water and seawater, and may be represented either as a concave curve or as two linear lines. In the former case, the removal of iodate during estuarine mixing is implied. In the latter case, a mixing process involving three end-members would have to be invoked. The three end-members may be Atlantic Ocean water, Chesapeake Bay water and James River water with salinities and concentrations of iodate of 32.7 o/oo, 17 o/oo and 0 o/oo, and 0.241 μM, 0.06 μM and undetectable amount, respectively.

THE EFFECTS OF ISOTROPIC MULTIPLE SCATTERING AND SURFACE ALBEDO ON THE PHOTODISSOCIATION FREQUENCIES OF TROPOSPHERIC SPECIES. S.N. Tiwari and T.R. Augustsson*. Dept. of Mech. Eng. and Mechanics, Old Dominion University, Norfolk, VA 23508

In order to accurately calculate photodissociation frequencies of troposphere species, radiation into and through the troposphere must be determined. Most tropospheric photochemical models use the so called Leighton approximation, which effectively represents a one-stream approach, to calculate the radiation field. The present study shows results calculated with a one-dimensional time-independent tropospheric photochemical model that has been coupled to a radiative model that accurately accounts for all important physical processes in the troposphere: (i) Rayleigh and Mie scattering, (ii) surface albedo and (iii) pure absorption by trace gases such as ozone. Results comparing the Leighton approximation to the multiple scattering calculations indicate that key photolytic processes, such as photodissociation of ozone, are significantly altered when the more realistic radiative model is used. Differences as large as factors of three and four were obtained using an albedo of 0.25. This work was supported by NASA Langley Research Center through cooperative agreement NCCI-30

TEMPORAL VARIATIONS OF NUTRIENT CONCENTRATIONS IN THE LOWER CHESAPEAKE BAY AND THE INNER VIRGINIAN SHELF. J.F. Todd and G.T.F. Wong*, Dept. of Oceanography, Norfolk, VA 23508.

Salinity and dissolved nutrient concentrations were measured in surface waters of the lower Chesapeake Bay and Inner Virginian continental shelf from March to October of 1980. The objective of this research was to investigate the Chesapeake Bay outflow on the water quality and productivity of the Inner Virginian shelf.

Lower Chesapeake Bay water contains higher concentrations of nutrients than offshore waters. Thus, Chesapeake Bay is a potential source of nutrients to the adjacent shelf waters.

Within 6 hours, variations in salinity concentrations of 5 o/oo, ammonia by a factor of 7, nitrate by a factor of 5, and phosphate by a factor of 2, were observed at a station in lower Chesapeake Bay. Silicate varied by a factor of 35 within one week at the same station. Similar nutrient variations were observed from June to October, 1980.

Due to the similarities in the relative magnitudes of the changes in salinity and nutrient concentrations in the various time scales, it is difficult to establish seasonal variations of these parameters and to accurately measure the flux of nutrients to the shelf waters.

Pb-210 AND Cs-137 GEOCHRONOLOGY AND THE DISTRIBUTION OF SELECTED HEAVY METALS IN A CORE FROM BACK BAY, VIRGINIA. J.F. Todd and G.T.F. Wong*, Dept. of Oceanography, Old Dominion University, Norfolk, VA 23508.

The concentrations of Pb-210, Cs-137, Cu and Zn at various depths in a core from Back Bay, Virginia were measured. The concentration of Pb-210 was uniform in the first 4 cm of sediment, and then decreased exponentially to a depth of 18 cm, where a sharp decrease to a constant level was observed. A sedimentation rate of 6.2 mm/yr was calculated from the data between 2 and 18 cm. Cs-137 concentrations of 1 pCi/g were found in surface sediments. The concentration decreased to below detection limit at 18 cm depth. If the horizon at 18 cm is assumed to represent 1954, the year at which atmospheric deposition of Cs-137 became detectable, a sedimentation rate of 7 mm/yr can be calculated.

Cu and Zn varied from 7 and 37 μg/g in surface sediments to 6 and 34 μg/g at 12 cm, respectively. The concentrations of both metals in the surface sediments were lower than those observed in James River sediments by a factor greater than 2, suggesting a possible higher anthropogenic input to the James River sediments. Fluxes of Cu and Zn to the Back Bay core were calculated to be 2 and 12 μg/cm²/yr, respectively.

ENRICHMENT OF ORGANIC CARBON AND CHLOROPHYLL a IN THE SURFACE MICROLAYER OF COASTAL FRONTAL ZONES. D.J. Velinsky, T.L. Wade , Dept. of Oceanography, Old Dominion Univ., Norfolk, Va. 23508

Surface microlayer (top 150um) and subsurface (20cm below the surface) water samples were collected from estuarine frontal zones at the mouth of Chesapeake Bay and analyzed for total organic carbon (TOC), chlorophyll a (Chla) and phaeo-pigments (pp). The concentrations of these parameters show large variabilities, but several trends are still apparent. The concentrations of TOC and pp were generally higher in the surface microlayer than in subsurface waters, while Chla concentrations were approximately the same at both depths. The concentrations of TOC, Chla, and pp are generally highest at the front and decrease away from the frontal interface. This indicates that chemical and biological materials first collect at the sea surface, then convergence of water masses at frontal zones cause these materials to concentrate at the frontal interface. These processes may also concentrate anthropogenic organic materials such as petroleum hydrocarbons at the frontal interface.

THE TEMPORAL AND SPATIAL DISTRIBUTION OF ANTHROPOGENIC HYDROCARBONS ENTERING LOWER CHESAPEAKE BAY IN ASSOCIATION WITH BULK PRECIPITATION. David B. Webber* and Terry L. Wade, Dept. of Oceanography, Old Dominion University, Norfolk, VA 23508.

Bulk precipitation samples were collected at four stations surrounding lower Chesapeake Bay from November 1980 to April 1981. Hydrocarbon concentrations in these samples were highly varied and ranged from less than 2 to 298 μg/ℓ. Samples collected during the winter months reveal a much greater concentration of anthropogenic hydrocarbons than do the samples collected in the spring months. However, these spring samples showed a predominance of odd chained n-alkanes most likely originating from pollen. This indicates seasonal trends of hydrocarbon concentrations in association with atmospheric fallout.

Hydrocarbon concentrations averaged 110 μg/ℓ in the urban site at Norfolk and 28 μg/ℓ in samples from the remaining non-urban sites. These concentrations are several times greater than typical hydrocarbon levels found in lower Bay waters and indicate that spatial distribution is also a very important factor to be considered.

This preliminary study has demonstrated that the atmosphere may be a significant source of hydrocarbons to the Bay. Further studies are needed in order to gain more complete seasonal data on these inputs.

METEOROLOGICAL ASPECTS OF USING LIDAR FOR
ATMOSPHERIC POLLUTANT SENSING. S. M. Zubrick*.
Dept. of Geophysical Sciences, Old Dominion Univ.,
Norfolk, VA 23508
    The three dimensional ozone structure downwind
of industrialized urban areas is not fully char-
acterized by present methods. Proper control
strategies require the impact of transported urban
ozone on downwind areas. The NASA/Langley Re-
search Center experimental airborne LIDAR system
remotely senses vertical ozone and aerosol pro-
files within the planetary boundary layer afford-
ing the capability to adequately characterize an
urban ozone plume.
    Discussions of the diurnal planetary boundary
layer evolution under fair-weather high pressure
systems are used to qualitatively explain the
three dimensional ozone structure. Airborne LIDAR
flight strategies are developed that would char-
acterize an urban ozone plume and provide a useful
data base for ozone modeling efforts.

Geology

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LAMELLAE IN SOILS: MODERN SECONDARY STRUCTURES. C.R.Berquist Va. Div. of Min. Res., Dept. of Geology, College of William and Mary, Williamsburg, Va. 23185

Although lamellae are commonly found in sandy soils, little is known of their genesis. A few observations can be added to help in understanding their formation.

Near Chincoteague, Va. lamellae and human graves were found together in the sides of a sand pit. The sediments at this location are correlative with Norfolk or younger units. These lamellae consist of irregular but continuous horizontal brown sheets of clay-enriched sand in a clean, fine- to medium-grained sand. In outcrop these sheets appear as bands and occur between ½ m. and 3½ m. below ground level. Above and within the graves the lamellae range in thickness from 2 to 4 mm. and are spaced from 5 to 10 cm. apart. As much as 1.5 m. below the graves the (older) lamellae are thicker (0.5 to 2 cm.) and more closely spaced (2 to 7 cm). Since the upper lamellae pass from above the human remains into undisturbed soil adjacent to the grave, they have formed since burial of the individual or within about the last 160 years. This date is based on finding machine-cut nails in one of the caskets.

PETROLOGY OF AN ANDESINE ANORTHOSIDE BODY NEAR MONTPELIER, VA. K. L. Bick, Dept. of Geology, Coll. of William and Mary, Williamsburg, VA 23185.

The mineralogy, textures and chemical composition of an andesine anorthosite near Montpelier, VA were studied to characterize the intrusive and determine the effects of metamorphism of the body.

The anorthosite body consists of two phases: a coarse, gray nonfoliated anorthosite and a white highly granulated, foliated anorthosite. The essential minerals of the coarse or primary anorthosite were plagioclase (An36), pyroxene, quartz and apatite before later alteration introduced amphibole and chlorite as a pesudomorphic replacement of the pyroxene. The andesine occurs in two textural varieties: antiperthite and myrmekite. Accessory minerals include ilmenite, rutile, garnet, biotite and sphene. The granulated anorthosite is composed of plagioclase (An34), quartz, microcline and biotite.

Anorthosite was probably emplaced in the schist through passive intrusion during the pC. After cyrstallization the area was subjected to intense regional metamorphism. Granulation and recrystallization of the primary northosite produced the granulated anorthosite.

PRELIMINARY SURFICIAL GEOLOGY OF THE VIRGINIA COASTAL PLAIN SOUTH OF THE JAMES RIVER. C.R. Berquist (Va. Div. of Min. Res.), G.H. Johnson and K.M. Farrell* (Va. Div. of Min. Res.), Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185.

Regional investigation has shown that a clayey silt (Sedley Formation of Moore, 1956) is a mappable upper member of the Yorktown Formation. West of the Surry scarp the feldspathic, fining upward Bacons Castle Formation (fluvial-deltaic ?) unconformably overlies the Yorktown and is a major surficial unit. Sediments deposited by repetitive transgressive-regressive cycles occur east of the Surry scarp and along rivers. The Windsor Formation unconformably overlies the Bacons Castle and older units. It includes sand and clayey silt members (barrier-lagoonal "Moorings unit" of Oaks and Coch, 1973) in the vicinity of the Surry scarp. A fining upward sequence (nearshore marine to lagoonal) of the Windsor Formation occurs east of the scarp. Two fluvial-estuarine, fining upward sequences occur along major rivers and are younger than the Windsor and older than the Norfolk Formation. Previously, one of the units was mapped as Norfolk, the other as Windsor. Two late Pleistocene marine-barrier sand complexes, the Norfolk and Kempsville-Sandbridge Formations of Oaks, occur between the Suffolk and Hickory scarps and between the Hickory and Oceana ridges, respectively. Possibly a younger thin silt and sand sequence lies between the ridges and the Holocene beach-dune-bay deposits along the coast.

TRACE MERCURY IN SURFICIAL MATERIALS ASSOCIATED WITH SULFIDE DEPOSITS NEAR MINERAL, VIRGINIA. J. R. Bosco*, and G. D. Robinson, Dept. of Geology, James Madison Univ., Harrisonburg, Va. 22807

Hg offers certain potential advantages in exploration because its volatility allows diffusion through rock pore spaces. This study was undertaken to test the exploration feasibility of determining Hg in Mn-Fe oxide coatings on stream alluvium. Such coatings act as scavengers for several metals, and are therefore important to geochemists.

Soil samples and coated pebble samples were collected near Mineral, Va., from areas overlying sulfide mineralization as well as from barren country rock. Based upon a partial digestion technique, Hg in the coatings is distinctively enriched near the mineralized zone, particularly when concentrations are expressed as a ratio to Fe. Cu/Fe produces a similar although less well-defined pattern but coating Zn is not a reliable indicator of mineralization. The opposite trend is evident in the soil where both Cu and Zn clearly delineate the mineralized zone, but not Hg.

The fact that Hg concentrations in coatings indicate the mineralized zone but soil concentrations do not is considered to be significant because determination of soil Hg is a generally accepted exploration technique, although erratic results sometimes occur. Results of this study suggest that even in areas where soil Hg concentrations are erratic, its concentration in alluvial coatings may still delineate mineralization.

NEW ASPECTS OF EXPLORATION FOR VOLCANOGENIC MASSIVE SULFIDES IN THE ANDERSONVILLE-WILLIS MOUNTAIN AREA, CENTRAL PIEDMONT. Richard S. Good, Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903.

A series of massive and massive-disseminated Zn-and Cu-bearing pyrite-pyrrhotite lenses of potential economic interest was discovered near Andersonville in the 1950's. Drilling on two zones showed 794,000 tons of 4,68% Zn, 0.60% Cu and 555,500 tons of 4,87% Zn and 0.98% Cu. The sulfides are refolded and stratabound within the dominantly mafic unit of the Lower Cambrian Chopawamsic Formation. Numerous thin ferruginous quartzites (recrystallized distal volcanogenic cherts) are also stratabound within the Chopawamsic and are proximal to the sulfide zones or grade into them. Geochemical anomalies of sand-sized sediments of Fe, Cu, Zn, Pb, Co, and Mn are strikingly associated with Fe-quartzites. Known and also new sulfide zones were clearly indicated by refined geochemical techniques. The Cattail Creek area is one of the new anomalies recommended for drilling. The stratabound sulfide bodies were formed on the ocean floor from hot brines and "smoker plumes" in a confined, back-arc basin close to a subduction zone. Gold and kyanite found in post-Chopawamsic quartzites and schists are also interpreted as being volcanogenic, but both minerals were reworked by fluvial or shallow tidal processes. The Willis Mountain kyanite deposits contain accessory pyrite-gold-hematite-fuchsite-rutile ± topaz and show similarities to the Cambrian (?) Haile and Brewer volcanogenic gold deposits of the Carolina slate belt, S. Carolina.

GEOMORPHIC EVIDENCE FOR MULTIPLE EPISODES OF DEBRIS AVALANCHING IN CENTRAL VIRGINIA. R. C. Kochel*, R. A. Johnson*, and R. J. Wayland*. Dept. of Environmental Sciences, Univ. of Virginia, Charlottesville, VA 22903

Heavy rains associated with Hurricane Camille in August 1969 triggered hundreds of debris avalanches on steep slopes in Nelson County, Virginia. Debris avalanching appears to be a major denudational process in the central Appalachians. These events are typically associated with catastrophic floods in master streams in the area.

Debris avalanche deposits partially preserved on alluvial fans in the Davis Creek watershed show evidence of up to three episodes of debris avalanching. The deposits are very poorly sorted mixtures of granite-gneiss cobbles and boulders with a sand and mud matrix. Each deposit has an erosional base and may be inversely graded. Criteria for recognizing individual events include buried soil horizons, texture, mineralogy, grading, clast weathering, matrix clay content, and induration.

Davis Creek floodplain deposits contain sediments from at least two major floods, each separated by well-developed buried soil horizons. The 1969 flood sediments contain clasts having average intermediate diameters an order of magnitude coarser than the underlying deposits, which suggests that the Camille flood was of considerably greater magnitude than earlier floods. Inversely graded sediments and transport of large rip-up soil clasts intact suggest that the flow was similar to a fluid debris flow.

SEDIMENT BUDGET AND NOURISHMENT AT VIRGINIA BEACH, VIRGINIA: 1979 1980. M.C. KAY and G. AUGUST*. Dept. of Oceanography, Old Dominion University, Norfolk, Virginia 23508

A study was conducted at Virginia Beach, VA to determine the annual sediment budget of an 8 km section of shoreline extending from Rudee Inlet northward to Cape Henry, VA. 12 profile stations were surveyed monthly for 13 months from Sept. 1979 to Sept. 1980. Profiles extended from backshore seawall or duneline to mean low water, and were obtained by a method similar in principle to the use of Emery Rods.

A total of 216,000 m³/yr of nourishment material was placed on the southern 4.6 km section of the study area, but it was not possible to subtract out the effects of artificial nourishment from the budget to determine the natural unnourished state of the beach.

The overall study area experienced net accretion of 40,000 m³/yr, the southern nourished section underwent net erosion of 6,000 m³/yr, and the northern unnourished section showed 46,000 m³/yr net accretion. These annual net sand volume changes were on the same order of magnitude as monthly net accretion and erosion; overall study area ranged −45,000 to +37,000 m³/month, nourished section ranged −35,000 to +28,000 m³/month, and unnourished section ranged −27,000 to +32,000 m³/month.

A single storm event caused 124,500 m³ net erosion along the entire study area and thus could negate months and/or years of net accretion. Storm events may also explain the lack of observed seasonal trends in accretion and erosion at Virginia Beach, Virginia.

SOME STRATIGRAPHIC DETAILS OF THE OTTERDALE SANDSTONE IN THE RICHMOND BASIN. Bruce K. Goodwin, Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185

The Otterdale sandstone occurs as an elongate unit extending from the Richmond basin's western margin northeastward for about 10 miles. Exposures contain very coarse-grained arkosic sandstone to arkose; pebbly, very coarse-grained arkosic sandstone; conglomerate; and minor silty, fine-grained sandstone and siltstone. The coarse-grained sandstones are commonly cross-stratified and the conglomerates commonly occur at the base of channels cut into the finer grained rocks. A few boulders of granite and gneiss are sparsely disseminated in the sandstones.

A 1514 foot measured section of the Otterdale sandstone was obtained from a cored drill hole .4 mile from the basin's western margin. The bottom third of this section consists of 40% pebbly to conglomeratic, very coarse- to coarse-grained sandstone; 7% conglomerate; 9% coarse-grained sandstone; 7% pebbly, fine-grained sandstone; 13% fine-grained sandstone; 23% silty, very fine-grained sandstone; and 1% shale. Coarse-grained sandstone and conglomeratic sandstone also dominate the upper two-thirds of the section.

Northeastward, the Otterdale sandstone becomes less conglomeratic, thinner, overlies the Vinita beds, and interfingers with the Vinita beds. Pebbly and arkosic, coarse-grained sandstones still dominate, but sandy siltstones become more abundant and a few thin shale beds appear.

STRUCTURAL EFFECTS ON SLOPE FAILURE OF DEBRIS-AVALANCHES IN NELSON COUNTY, VIRGINIA. L. D. Lisle* and R. C. Kochel* Dept. of Environmental Sciences, Univ. of Virginia, Charlottesville, Va. 22903.

Bedrock structure has been shown to play an important role in geomorphic processes. The bedrock structure of Davis Creek Basin, Nelson County, Virginia, was examined to determine if it had any influence on the frequency and distribution of debris-avalanches initiated by the 1969 Hurricane Camille storm. 417 joints were measured and analyzed on three debris-avalanche chutes in the basin. The basin is underlain by the Precambrian Lovingston granite gneiss which has a foliation parallel to the dominant joint set orientation of N.56°E.,70°SE. The north-facing chutes have relatively smooth bedrock surfaces while the surface of the south-facing chute is irregular. No sheeting joints were observed on the south-facing chute. Its surface is oriented 40° from the dominant joint set. North-facing chutes are oriented 80° to 90° from the dominant joint set and contain sheeting joints. The north-facing chutes appear to be controlled by sheeting joints while the south-facing chute appears to be controlled by the dominant joint set. Greater surface and, therefor, higher surface friction on the south-facing chute may explain the lower failure frequency on south-facing slopes than on north-facing slopes.

BILLION-YEAR-OLD ROCKS OF THE BLUE RIDGE ANTICLINORIUM OF NORTHERN VIRGINIA: A REVIEW. James W. Clarke, U. S. Geological Survey, Reston, Va. 22092

The Blue Ridge anticlinorium extends about 880 km from Georgia to Pennsylvania. From Lynchburg, Va., for about 225 km northeastward into Maryland, the anticlinorium has a central core of billion-year-old metamorphic rocks. These rocks have been mapped in detail in the Orlean quadrangle in northern Virginia. A major fault extends northeastward through this quadrangle and divides it into two different terranes. On the west, the oldest rock is the Flint Hill Gneiss, which is a strongly layered and foliated granitic gneiss. It characteristically contains numerous veins of blue quartz. A Pb-207/Pb-206 zircon age of 1081 m.y. has been obtained on this gneiss. The Flint Hill Gneiss is intruded by the Robertson River Granite, which has a nearly concordant Pb-207/Pb-206 age of 701 m.y. To the east of the major fault, the oldest mappable rock unit is a biotite augen granitic orthogneiss. This gneiss carries a few xenoliths of banded injection gneiss, which could be fragments of older crust. This augen gneiss is intruded by Marshall Metagranite, which is a moderately foliated biotite granite to quartz monzonite. Characteristic of the Marshall is a bimodal grain-size distribution of the quartz at 0.2-0.3 mm and 1-2 mm. The coarser quartz is commonly blue. The Pb-207/Pb-206 zircon age obtained for the Marshall is 1010 m.y. The rocks of the Orlean quadrangle and vicinity do not contain hypersthene and hense do not appear to have reached the granulite grade of metamorphism.

CHARACTERISTICS OF SOME SOILS OF THE DISMAL SWAMP. Joseph
H. Rule and Terri Manfredi Mathews.* Dept. of Geophysical
Sciences, Old Dominion University, Norfolk, Va. 23508.

Research conducted in the Dismal Swamp of Virginia during
1980 studied the soils under four different forest communi-
ties within the swamp. The soils at each site were charac-
terized which allowed division of these into one Histosol
and three mineral soil types. The profiles of the three
mineral soils were found to be quite different physically
from one another yet similar chemically. Chemical parameters
measured on the soils include pH, cation exchange capacity
and exchangeable cations. The pH of the soils are all
generally below 5.0 with little variation down the profile.
Cation exchange capacity is moderate to high with H^+ domi-
nating the exchange complex. Exchangeable base cations are
extremely low. Although the majority of soils in the Dismal
Swamp are Histosols, this study has examined three important
areas of mineral soils that exist in the swamp. All soils
studied had quite variable soil properties and low nutrient
status. (Aided by NSF grant no. DEB-7708609-A01)

GEOCHEMISTRY OF AN UNUSUAL CARBONATE-RICH SOIL IN ROCKINGHAM
COUNTY, VIRGINIA. E. R. McFarland and W. C. Sherwood, Dept.
of Geology and Geography, JMU, Harrisonburg, VA 22807

A carbonate-rich Mollisol designated the Massanetta Series
was recently mapped in western Virginia along streams drain-
ing faulted carbonate bedrock. An area in SW Rockingham
County was chosen 1) to investigate the carbonate in the
soil, and 2) to explain the geochemical environment. The
soil profile is approximately 150 cm thick and is underlain
by a coarse river gravel. Augering to 120 cm showed weakly
developed A, B and C horizons. Carbonate content increased
with depth to 65% in the C horizon where it occurs both as
white powdery flakes and as hard crusty layers.

Laboratory analyses were conducted on the soil and stream
waters. X-ray work showed all the carbonate to be calcite.
AA analyses of the calcite yielded Mg/Ca and Sr/Ca ratios
ranging from .0053 to .0008 and from .00035 to .00017 re-
spectively. Stream water samples contained (in ppm except
for pH): Ca from 120 to 170; Mg from 37.4 to 63.6; Sr from
0.8 to 1.2; and pH from 7.8 to 8.9. Hydrolysis and ionic
effects were computed and the waters were found to be appro-
ximately at saturation.

Assuming that all of the groundwater entering the study
area contains similar ionic concentrations, it is concluded
that these waters move freely through the underlying coarse
gravels, are then taken up into the finer overlying soil by
capillary action, and deposit calcite due to surface evapora-
tion.

MICA AGES AND UPLIFT HISTORY IN THE VIRGINIA PIEDMONT.
D.G. Mose, Department of Chemistry and Geology, George
Mason University, Fairfax, Virginia 22030, and A. Tunsoy*,
Department of Geology, Florida State University, Talla-
hassee, Florida 32306

Radiometric age determinations by the K-Ar and Rb-Sr
techniques on biotite and muscovite in metamorphic rocks
have long been used to determine the time at which a meta-
morphic terrane cooled to a temperature of about 300° C,
below which biotite and muscovite begin to retain radio-
genic argon and strontium. Recent mica age determinations
in the Piedmont of central Virginia yield early Triassic
ages of about 200 million years. These ages may be taken
to indicate that these metamorphic rocks were at elevated
temperatures for a prolonged interval following the early
to middle Paleozoic metamorphic episode. An alternate
possibility is that these mica ages represent a post-
metamorphic interval of temperature elevation, perhaps
related to crustal tension and thinning which preceded
Triassic rifting and the upward movement of mantle derived
magmas.

RADIOMETRIC AGES OF PLUTONS FROM THE VIRGINIA PIEDMONT
ALONG THE JAMES RIVER. D.G. Mose and M.S. Nagle*,
Department of Chemistry and Geology, George Mason Univer-
sity, Fairfax, Virginia 22030

Rb-Sr whole-rock age determinations have recently been
obtained for plutonic rocks in the central Virginia Pied-
mont. The oldest unit yet dated is the State Farm pluton,
a granodioritic magma which intruded high-grade metamorphic
rocks in the eastern Piedmont near Richmond at 1031 ± 47
m.y. ago. Metamorphosed units to the west include the
Chopawamsic volcanics of middle Cambrian age (U-Pb dating:
about 530 m.y. old). The Chopawamsic volcanics were intru-
ded by the Columbia pluton of middle-late Ordovician age
(Rb-Sr dating: 454 ± 9 m.y.) and the Occoquan pluton of
late Cambrian or early Ordovician age (Rb-Sr dating: 494 ±
14 m.y. old). These plutonic and volcanic rocks were
overlain by the Arvonia and Quantico slates of late Ordo-
vician age (fossil dating).

CHEMISTRY OF CATOCTIN FLOWS AND FEEDER DIKES IN VIRGINIA.
M.S. Nagle*and D.C. Mose, Department of Chemistry and
Geology, George Mason University, Fairfax, Virginia 22030

The Catoctin Formation in the Blue Ridge Anticlinorium
consists mostly of a fine grained greenstone which is
thought to represent late Precambrian continental rift
volcanism. The chemical composition of the greenstone
has been altered from the original volcanic composition by
weathering, metamorphism and spilitization. It has been
demonstrated by previous workers that major elements in the
Catoctin Formation have undergone chemical mobility. It
can be shown that other elements are more useful for det-
ermining the original rock type of the Catoctin volcanics.
Application of a cation tertiary plot developed by Jensen
shows that the Catoctin volcanics have a chemical composi-
tion which falls in the tholeiitic field, with a strong
iron enrichment.

Numerous mafic dikes have been located in the Blue Ridge
Anticlinorium. When chemical analyses of the dike rocks and
the Catoctin volcanics are plotted on the tertiary plot of
Jensen, it is clear that the field of chemical analyses
from the dike rocks is nearly identical to that of the vol-
canics. This suggests that the intrusions could have been
feeder dikes for the Catoctin volcanics.

RICHMOND COAL: A PRELIMINARY STUDY OF ITS
MINERAL CONTENT. M. A. Potts*, Dept. of Environ-
mental Sciences, The University of Virginia,
Charlottesville, Virginia 22903.

Nine bituminous coal samples from three local-
ities along the Eastern edge of the Richmond coal
basin (Triassic) were studied using X-ray diff-
raction powder cameras. Both unheated and heated
(400°C-48 hours) samples were analyzed. Quartz
and kaolinite were present in all samples.
Pyrite, while not present in all the samples,
was found in coals from the three areas studied.
Gypsum (bassanite) and calcite were present in
minor amounts in some samples. These results
correlate well with earlier chemical and miner-
alogical data for the Richmond coal. Three
samples of coal from other Triassic deposits in
Virginia contained one or more of the following
minerals: quartz, pyrite, calcite, and illite.
All the Triassic coals studied are similar in
mineral composition to Eastern coals (Pennsyl-
vanian) studied earlier by Mitchell and Glus-
koter (1976), which differ from Western coals
that are characterized by the presence of signif-
icant gypsum and lesser amounts of calcite and
pyrite.

FEEDING STRATEGIES DISPLAYED BY THE TRACE FOSSIL PALEOBUL-
LIA IN THE PENNSYLVANIAN OF EAST TENNESSEE. K.W. Ramsey
and M.F. Miller*, Dept. of Geology, Vanderbilt Univ.,
Nashville, Tn. 37235
    Occurrence of facies-restricted trace fossils, degree of
bioturbation and variations in trace morphology are impor-
tant aids in the interpretation of depositional environ-
ments. Surface traces in the Pennsylvanian (Fentress Fm)
of the Cumberland Plateau of upper east-central Tennessee
are possible remnants of the grazing trails of gastropods
(Paleobullia). These traces reflect foraging patterns in
the form of looping trails made in the search for food on
apparently homogeneous bedding planes. The circular pat-
tern of the loops probably reflects the most efficient
means of foraging in isolated areas of high food-resource
potential. The association of these trails with interfer-
ence ripples and mud cracks suggests an intertidal habitat,
possibly the barren zone of an intertidal lagoon. The lack
of bioturbation other than the isolated trails and the uni-
formity of the micrograded sandstones with thin shale inter-
beds in which the traces occur supports this interpretation.
    Many trace fossils are strongly facies controlled (Seil-
acher, 1967). Trace fossils in the Pennsylvanian rocks
studied have narrow paleoenvironmental ranges. In addition,
the trace fossils give the only evidence of biologic acti-
vity in otherwise unfossiliferous rocks. In similar trace-
rich Coastal Plain deposits of Virginia, biogenic structures
may be useful indicators of depositional and faunal regimes.

A PARAGENETIC STUDY OF THE UNIQUE ELMWOOD/GORDONSVILLE
MISSISSIPPI VALLEY-TYPE DEPOSITS. Robert R. Seal, II*,
sponsored by W. D. Lowry. Dept. of Geological Sciences,
Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.
    The Elmwood/Gordonsville deposits of Central Tennessee
are typical Mississippi Valley-type ores within the Lower
Ordovician carbonates on the southeast side of the Nash-
ville Dome. The ore minerals, which occur as breccia in-
fillings, are dominated by coarse-grained sphalerite with
minor amounts of galena, pyrite, and marcasite. Fluorite
and barite overgrowths are common. The ore textures have
been studied in doubly polished thin sections which permit
transmitted and reflected light examination of the same
specimen.
    Paragenetic study reveals that small quartz euhedra grew
along the edges of carbonate breccia fragments before zinc
sulfide deposition. The sphalerite, with carbonaceous
material throughout, occurs as interlocking grains that
exhibit abundant growth features. At least two generations
of sphalerite are present. In transmitted light, the
sphalerite has a distinctive anisotropy characterized by
"gridiron" textures which appear similar to microcline
twinning.

ORIGIN OF AN EARLY CAMBRIAN(?) GRANITE IN CENTRAL VIRGINIA.
Sheila F. Smith, Dept. of Geophysical Sciences, Old
Dominion University, Norfolk, Va. 23508
    A 1 X 6km granite pluton crops out on either side of the
Rockfish River, Nelson County, Virginia ($37°49'N,78°46'W$).
Although contacts with the host Lovingston Formation and
an as yet unamed granodiorite were not observed, outcrop
patterns indicate a concordant pluton.
    Based on Rb/Sr ratios, the age of the granite is 570 $\pm$
50 m.y. The initial $^{87}Sr/^{86}Sr$ ratio is 0.7229.
    Mortar structures, mosaic grains and offset albite twins
in the plagioclase indicate cataclasis. The rock has
undergone low-medium grade metamorphism.
    Peraluminous chemistry and the initial $^{87}Sr/^{86}Sr$ ratio
indicate that the granite fits the criteria for an S-type
granite – that is, derived from crustal sources by partial
melting.(Aided by a Grant-in-Aid -of-Research, Sigma Xi,
The Scientific Research Society)

COLLUVIUM AND HIGH-LEVEL ALLUVIUM, CULPEPER COUNTY, VIRGINIA.
G. Richard Whittecar, Department of Geophysical Sciences,
Old Dominion University, Norfolk, Virginia 23508.
    Excavations for a large oil pipeline crossing the central
Virginia Piedmont exposed multiple colluvial deposits over-
lying high-level alluvium. The thickest ancient alluvial
sediments visible in the ditch in Culpeper County rest upon
bedrock terraces lying 15 meters above the Rapidan River and
tributaries. The fining-upward fluvial sediments, 0 to 2.8
meters thick, are heavily weathered and impregnated with
pedogenic clay to at least 2 meters depth. Rounded to sub-
rounded basal gravels consist of varied non-local lithologies.
Massive, very poorly-sorted colluvium blankets nearly all
slopes along the pipeline transect. Commonly the colluvium
is less than a meter thick and has a stoneline or other dis-
tinct boundary at its base. Coarse angular fragments of vein
quartz and phyllite that are irregularly distributed through-
out the silt loam matrix indicate the colluvium is of local
origin. Multiple generations of over-thickened colluvium are
distinguishable at two study sites based upon relationships
of color, stonelines, and geomorphic position. Although no
datable material was found at the sites, soil development
suggests that the thick colluvial wedges are no older than
late Pleistocene but that the high-level alluvium is signifi-
cantly older than the colluvium.
(Aided by ODURF Grant 80-964.)

MORPHOLOGIC BED CHANGES BETWEEN TWO ADJACENT GROINS DURING
A TEN-WEEK PERIOD AT WILLOUGHBY SPIT, NORFOLK. Kim
Zauderer*, Al Moore*, Dept. of Oceanography, Old Dominion
Univ., Norfolk, VA 23508.
    The zone between two adjacent groins in an extensive
groin field was selected for a study of morphologic varia-
tions of the bed above and below Mean Low Water (MLW). The
bathymetric data were obtained using a profiling method.
Eight surveys were made between 12 May and 22 July, 1980.
Results indicate that morphologic changes which occur below
MLW are quite different in character from those above MLW.
    An inner bar formed during the profiling period in the
eastern nearshore zone of the study area. Data also
revealed a trough located near the end of the groins and
parallel in trend to the shoreline. Adjacent and bayward
of this trough a bar occurred which also trended parallel
to the shore. Elevation changes of ± 0.5m were commonly
observed between sampling days. The data suggest that
regions within the profiled area change at different rates
in response to changing wave conditions; moreover, the
offshore trough and bar may respond to the spring tide
cycle. The nearshore region from MLW to MHW responds
quickly to daily wave conditions. The beach foreshore and
backshore respond to more energetic wave conditions.

Materials Science

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THE MELTING BEHAVIOR OF MICROCRYSTALS OF LEAD AND ALUMINUM.
G. L. Allen* and W. A. Jesser, Dept. of Materials Science,
Univ. of Va., Charlottesville, Va. 22901
      TEM studies of the melting behavior of small lead and
aluminum particles were performed in-situ. A melting point
that decreases with decreasing particle radius was observed
for lead. This size-dependent melting can be expressed as a
nearly linear relationship between melting temperature and
inverse particle radius for particles with diameters of 100 Å
and more. For the size range of 60 to 100 Å in diameter, a
steeper slope is shown by the data. Furthermore, lead
particles of 30 to 60 Å in diameter exhibit a melting temper-
ature above that of large particles when lead oxide is
present. These trends are consistent with the experimental
work of others. In the preliminary studies of aluminum, the
particles reacted with the substrate and no quatitative
melting point data was obtained. (funded by Army Research
Office)

DAMAGE DEVELOPMENT MECHANISMS IN NOTCHED COMPOSITE
LAMINATES UNDER COMPRESSIVE FATIGUE LOADING. N. F. Black*.
Eng. Sci. and Mech. Dept., Va Polytechnic Inst.,
Blacksburg, VA 24061.
      An investigation of the damage development mechanisms in
notched graphite epoxy composite laminates under compres-
sive fatigue loading is presented. The variation of dam-
age development in two different laminate configurations
and the effects of damage on material properties is ob-
served. Several nondestructive investigation techniques
were used to monitor damage during loading which included:
X-ray radiography, ultrasonic C-scan, ultrasonic attenua-
tion, acoustic emission, and stiffness change. In addi-
tion, some damaged specimens were sectioned to aid in the
interpretation of the nondestructive data.
      The investigation was conducted on AS/3501-6 graphite
epoxy laminates with two stacking sequences:
· $(\pm45,0_2,\pm45,0_2,\pm45,0,90)_{2s}$, (48 plies)
· $(\pm45,90,-45,+22.5,-67.5,-22.5,+67.5,\pm45,+67.5,+22.5,-67.5,$
   $-22.5,+67.5,+22.5,0_2,+22.5)_s$, (42 ply)
Several specimens of each laminate type were quasi-static-
ally loaded to failure to determine the ultimate compres-
sive strength. Fatigue tests were run at 60, 70 or 80 per-
cent of the ultimate strength for a duration of either
600,000 cycles, 10^6 cycles, or failure.

EXPERIMENTAL INVESTIGATION OF THE GAS BUBBLE MODEL OF HELIUM
EMBRITTLEMENT, J. I. Bennetch and W. A. Jesser, Materials
Science Dept., Univ. of Va., Charlottesville, Va. 22901.
      In a fusion reactor environment, helium ions and
neutrons from the plasma that strike the containment wall of
the reactor can cause a number of serious materials problems,
including loss of ductility or embrittlement.
      The phenomena of helium embrittlement in type 316 stain-
less steel foils were studied by in-situ tensile testing of
foils in a 500 kV high voltage electron microscope (HVEM)
attached to a linear light ion accelerator used at 80 kV.
      In order to examine the microscopic effects of helium on
ductility, the nature of cracks that nucleated in and propa-
gated through irradiated tensile samples was carefully
studied in light of current theories on helium embrittlement.
These theories have various critical parameters incorporated
in their equations. Among these are concepts of critical
cavity diameter d, and spacing L, cavity internal pressure P
and area fraction of grain boundary covered by cavities, α_R.
For test temperatures above 550° C, it was found that, con-
trary to expectations, α_R, d, L and P are apparently not
critical parameters which lead to brittle intergranular frac-
ture. Below that temperature, however, there was determined
a critical d and L for the onset of brittle fracture. In
this temperature region bubbles on the grain boundary may be
slightly overpressurized but even in this case no critical
α_R was found.

TECHNIQUES FOR THE DETERMINATION OF THE THERMAL CONDUCTIVITY
OF SMALL FIBERS AND FILMS. L. J. Adams and R. E. Barker, Jr.,
Dept. of Materials Science, Univ. of Charlottesville,
Va., 22903.
      Recent years have seen intense interest in polymeric
"one dimensional" extended chain conductors and semi-conductors
such as polysulfur nitrite and polyacetylene. Materials of
this type are expected to have interesting anisotropic
thermal properties. Although it is not yet known whether
their electrical conductivities are due to electrons or to
ions, extended chain polymers such as poly-paraphenylene
benzobisthiazole (PPBT) and polyparaphenylene terephthala-
mide (Kevlar) are expected, because of their high axial
modulus $Y_{||}$ to have an axial conductivity $K_{||} \approx 0.33 \, C_v \Lambda(Y\rho)^{\frac{1}{2}}$
$\approx 1 - 10 \, Wm^{-1}K^{-1}$ due to "lattice" vibrations. $C_v \Lambda$ is the
product of heat capacity and the phonon attenuation length.
Transverse thermal conductivities of fiber forming materials
are expected to be the usual values for insulating polymers,
namely $\approx 0.3 \, W \, m^{-2} K^{-1}$. Efforts to develop techniques for the
measurement of $K_{||}$ amd $K_\perp$ for fibrilous materials will be
discussed. For example, great difficulties in the determina-
tion of $K_{||}$ result from the large heat exchange coefficient
(h $\approx$ 200 $Wm^{-2}K^{-1}$) between small fibers and thin surrounding
space. Our most successful attempts to date have utilized
small thin films for the determination of $K_{||}$ followed by an
adaptation of a method due to de Senarmont to determine the
ratio of $K_{||}/K_\perp = (b/a)^2$ on wax coated films exposed to a
"point" heat source. The wax melts into an elliptical pattern
2a x 2b. The observed K-ratios are near 6 for PPBT. (Funded
by U.S. Air Force - OSR-80-0014)

ELECTRICAL CONDUCTIVITY OF HIGHLY ANISOTROPIC FIBERS AND FILMS OF POLY(P-PHENYLENE BENZOBISTHIAZOLE). D. Y. Chen* and R. E. Barker, Jr. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901.

Due to its molecular geometry poly(p-phenylene benzo-bisthiazole) tends to form an extended chain conformation. This tendency leads to an extreme anisotropy of mechanical and electrical properties. Experimental data, which will be discussed, reveal that the axial conductivity ($\sigma_{||}$) is 10^6 times larger than the transverse conductivity ($\sigma_\perp$). This large ratio along with the fact that the conduction is ohmic up to at least 1.2×10^5 V/m, is thought to imply one dimensional electronic conductivity. The presence of the "as received" acid content of samples affects the value of electrical conductivities. After washing in ethyl alcohol and then drying, PBT tends toward a value of electrical conductivity which is about 1/5 of the value for an un-treated sample. On the other hand a sample treated in a solution of amonium hydroxide tends to increase its electric-al conductivity to a much higher value. Thermal treatment (e.g. oven drying) also reduces electrical conductivities to lower values. In this paper some results will be discussed of special techniques which have been developed for measuring electrical conductivities of very small samples (10 to 40 μm diameter for fibers). (Work supported by the U.S. Air Force Grant AFOSR-80-0014.)

CHARACTERIZATION OF PRECIPITATES IN V-20TI ALLOY. S.A. Hackney* and K.R. Lawless. Dept. of Materials Science, Thornton Hall, Univ. of Va., Charlottesville, Va. 22903

A study of the low pressure oxidation of V-20Ti alloy has been carried out in-situ using a Hitatchi Million Volt Electron Microscope. The reaction temperatures have ranged from 300°C to 800°C and the O_2 pressure has been regulated at 3×10^{-5} torr. The results show that there are two simultaneous reaction pathways. The selected area electron diffraction patterns taken during oxidation indicate that as oxygen goes into solution, small crystallites of V_2O_3 are formed. There is evidence that at long reaction times or higher temperatures large TiO precipitates are formed by Ti reacting with the dissolved oxygen.

DEVELOPMENT OF TECHNIQUES TO STUDY VAPOR DIFFUSION AND SOLUBILITY IN FIBERS AND FILMS OF POLY(P-PHENYLENE BENZO-BISTHIAZOLE). W. S. Huang and R. E. Barker, Jr., Materials Science Dept., U.Va., Charlottesville, Va. 22901.

The study of the transport properties of polymers has added to the understanding of relations between macroscopic and microscopic properties. Little is known about transport properties in PBT and related extended chain polymers, which should be interesting due to their anisotropic character. This work deals with the determination of diffusion co-efficients D and sorption coefficients. It is part of a study that includes the determination of electrical and ther-mal conductivities of the same materials. PBT samples are available only in limited quantities as fine fibers ($\sim$ 20 μm-diameter) and thin narrow film, therefore we have focused attention on the development of sensitive techniques for such samples. Later, spectrophotometric and electron microscopic analytical techniques will be used, but up to the present time an apparatus based on a classical sorption balance with a sensitive quartz spring in a thermostated evacuable chamber has seemed the most suitable approach. Problems of interpret-ing the sorption balance data for anisotropic fibers with possible concentration dependencies of the pre-exponential factor D_0 and the activation energy E_D will be discussed along with related matters. (Funded by U.S. Air Force - OSR-80-0014)

CONSTRUCTION OF A QUANTITATIVE LOAD-ELONGATION SINGLE TILT, HOT TENSILE STAGE FOR HVEM USE. R.D. Gerke* and W.A. Jesser. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

Helium embrittlement in fusion reactor first wall material is studied by In-situ tensile testing over various temperatures in a high voltage electron microscope (HVEM) with an attached accelerator. The design of a tensile rod with load-elongation and high temperature capabilities is a useful tool to study the mechanisms of helium embrittlement. The tensile rod is operated by a hydraulic system which restrains a spring. The actual pulling force is provided by the spring. The hydraulic system consists of two fluid-filled bellows interconnected with tubing and valves. A slow metering valve governs fluid flow between the bellows which in turn controls elongation rate. A round 3.5 mm diameter heating element positioned under the tip of the stage allows for studies at temperatures up to 700° C. He$^+$ ion beam specimen current is monitored through use of the thermocouple also mounted at the tip of the electrically insulated rod. Load-elongation measurements can be deter-mined by use of two transducers: a linear variable differ-ential transformer (LVDT) used to determine elongation and total pulling force and a pressure transducer used to determine load exerted on the sample. (Funded by Office of Fusion Energy, Dept. of Energy)

IN-SITU HVEM OBSERVATIONS OF HIGH TEMPERATURE FRACTURE MECHANISMS IN NEUTRON-DAMAGED 304 STAINLESS STEEL. T. Hanamura and W. A. Jesser. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901

The purpose of this experiment is to investigate the nature of crack propagation during tensile testing of ir-radiated materials containing voids or bubbles. In this experiment five specimens were investigated. All unirradi-ated and helium-irradiated specimens were Type 316 stainless steel annealed at 1000° C for one hour. One specimen was neutron irradiated 304 stainless steel. It was found that the crack angle was small in the helium-irradiated sample. Scissors-like crack propagation occurred at higher tempera-tures (400° C) in both helium-irradiated and unirradiated specimens. Crack tip angle is correlated with crack tip radius and both decrease in front of the grain boundary. Grain boundary sliding occurred in both helium-irradiated and unirradiated specimens. The neutron-irradiated specimen showed typical intergranular crack propagation at 400° C while He-irradiated and unirradiated specimens showed trans-granular crack propagation at 400° C. The neutron-irradiated specimen showed a sharp crack angle and a very small crack tip radius compared to the other specimens.

CHARACTERIZATION OF SMALL Pb-Bi ALLOY PARTICLES. W.W. Gile* and W. A. Jesser. Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22901.

Specimens of Pb-Bi alloy microcrystals were prepared by co-vapor deposition of each element onto a heated amorphous carbon substrate. The deposition was performed in a diffu-sion-pumped vacuum system ($\sim 5 \times 10^{-4}$ Pa) with the substrate at $\sim 200^\circ$C. After deposition, an additional layer of pro-tective amorphous carbon was deposited on the specimen to limit oxidation and other contamination. The overall compo-sition of the specimens ranged from 20 to 80 wt.% bismuth and the particle diameters ranged from 5 to 500 nm. The charac-terization of the specimens was performed in a Philip's E.M. 400. The structure and average composition of the specimens were determined by selected area diffraction and X-ray micro-analysis. Determination of the structure and composition of individual microcrystals was accomplished by convergent beam diffraction and STEM X-ray microanalysis. The specimens were found to contain two or three of the three stable solid phases found in the bulk Pb-Bi system. Most of the individual microcrystals analyzed by convergent beam diffraction con-tained pairs of phases. The compositions of these micro-crystals were found to be size-dependent, with the smaller microcrystals being Bismuth-rich. The microcrystals were also quickly electron beam heated by removing the condensor aperture of the microscope. It was found that, during heat-ing, the relative evaporation rates of the Bi and Pb were very dependent on the composition of the particles and therefore on the phases present.

STRESSES IN MULTIPLE-PIN CONNECTORS: A PHOTOELASTIC APPROACH.
M. W. Hyer*, and D. H. Liu*, Engineering Science and Mechan-
ics, Virginia Tech, Blacksburg, Va. 24061.
    For some time there has been an interest in the effects of
through-the-thickness holes and other discontinuities in
plates. From a practical point of view there is generally no
way discontinuities can be avoided, particularly in regions
where plates must be connected to other structural members.
Most connectors use pins, bolts, or rivets in the holes to
serve as the actual connector. Photoelastic models can be
used to effectively analyse the stresses in connector regions.
Specific interest in this study centers on models of two-hole
connectors in a double-lapped joint configuration. The two
holes are in tandem, or series, and the joint is subjected to
tensile loads along the line joining the centers of the two
holes. The fasteners are snug-fitting pins. The photoelas-
tic models are constructed of photoelastic materials and a
transparent acrylic which is not photoelastic but which has
the same elastic properties as the photoelastic material. In
this manner, the photoelastic fringe patterns in the inner
laps can be seen through the acrylic outer laps. Because of
the ease of fabricating photoelastic models, many joint geo-
metries can be studied by fabricating joints of various
widths and lengths. The study shows that the stresses at one
hole can be about twice as great as the stresses of the other
hole. This trend is dependent on joint geometry.
    The work supported herein is sponsored by the NASA Langley
Research Center, Donald J. Baker, Jr. grant monitor.

CARBON ATMOSPHERE NEAR AN EDGE DISLOCATION IN IRON. A.S.
Nandedkar* and R.A. Johnson. Dept. of Materials Science,
Univ. of Va., Charlottesville, Va 22901.
    The distribution of carbon atoms near a $\frac{1}{2}<\bar{1}11>\{110\}$
edge dislocation in iron is calculated using an existing
interaction energy relationship between point defects and
an edge dislocation based on isotropic elasticity theory.
Empirical correction factors for energy relations are used
inside the core. The interaction between carbon atoms is
neglected.
    A block of fixed size, periodic along the dislocation
line, is taken as the computational cell, and the location
of octahedral sites in the vicinity of the dislocation is
determined from an elastic dislocation model. The Fermi-
Dirac distribution function is then used to compute
occupation probabilities of these sites. Due to the shape
interaction, these probabilities depend upon the orientation
direction of each site.
    Finally, this atomistic model is used to compute the
breakaway stress of an edge dislocation in iron from a
carbon atmosphere. (Supported by NSF grant No. DMR78-07539)

ANALYTIC PREDICTIONS OF THE ANNEALING RESPONSE OF REACTOR
VESSEL STEELS. A. P. Main* and B. L. Shriver, Dept. of Nuc-
lear Engr. & Engr. Physics, Univ. of Va., Charlottesville,
VA 22901.
    Several of the early light water reactor plants utilized
reactor vessels fabricated from steels having a relatively
low toughness and are experiencing increasing embrittlement
with irradiation. In these cases, the use of in-situ ther-
mal annealing is being considered to reduce the irradiation
embrittlement and, thereby ensure that brittle failure of
the reactor vessel will not occur. This paper discusses the
initial results of work being done at the Univ. of Va. to
provide a method for predicting the embrittlement recovery
resulting from thermal annealing.
    The U.Va. annealing model presently assumes that there
are three types of irradiation induced defects responsible
for the observed embrittlement as determined from shifts in
the reference transition temperature. The activation energy
of diffusion and distance to a sink for each defect is dif-
ferent, but no other properties are defined.
    The shift in the reference transition is assumed to be
proportional to the square root of the density of the de-
fects. Eash defect type contributes a different amount to
the embrittlement which is accounted for by the use of weigh-
ting factors. These weighting factors are determined by the
chemical composition of the material.
    Thus the model allows prediction of a materials response
to thermal annealing if the chemical composition is known.

HIGH RESOLUTION TEM STUDIES OF FINE-GRAINED α-IRON. J.
Newkirk* and H.G.F. Wilsdorf. Dept. of Materials Science,
Univ. of Va., Charlottesville, Va. 22901
    Polycrystalline α-iron filaments with diameters from
1000 Å to 30 μm can be produced by the decomposition of iron
pentacarbonyl. They are grown at 280° C in a magnetic field
and contain 1.5 w/o C and 0.8 w/o O. This growth process
results in an unusual microstructure and properties. The
filaments are very strong (6-8 GPa) and have no microporos-
ity. TEM reveals α-iron grains on the order of 100 Å in
diameter with grain boundaries which appear to be non-planar
and have widths of 10-20 Å. Grain orientations and shapes
have been studied and will be discussed along with a
comparison with grain boundaries in normally solidified
alloys.

Medical Sciences

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
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IN-VITRO BINDING OF PHENCYCLIDINE TO SERUM AND TISSUES FROM RAT. B.B. Bailey*, M.L. Lawrence* and B.R. Martin, Dept. of Pharmacology, Med. Col. of Va., Richmond, Va., 23298.

Previous distribution studies from our laboratory suggests that phencyclidine (PCP) has a low affinity for blood since PCP rapidly distributes from blood into tissues where it is sequestered. In order to compare serum binding of PCP to tissue binding, equilibrium dialysis was used. Sprague-Dawley rats were decapitated, blood collected and allowed to clot, and tissues homogenized in five volumes of buffer. Two ml of serum or tissue homogenate was added to dialysis tubing which was placed in 200 ml of phosphate buffer. ^{3}H-PCP (added to the buffer) came to steady-state with serum or homogenates within 24 hours. ^{3}H-PCP (10^{-6} to 10^{-9} M) had a greater affinity for tissue homogenates than for serum. At 10^{-7} M of ^{3}H-PCP, the order of binding (pmoles ^{3}H-PCP/mg protein) was brain (3.2), liver (2.9), lung (1.5) and serum (0.6). These data agree with the distribution data with the exception that PCP levels in lung and liver are higher than those in brain. Experiments were also carried out to determine if other drugs of abuse (morphine, nicotine, pentobarbital and diazepam) would compete with ^{3}H-PCP binding to serum. The only compounds that displaced bound ^{3}H-PCP were two of its metabolites and nicotine to a limited extent. (Supported by U.S.P.H.S. grant no. DA-02396).

IN VITRO STIMULATION OF CHONDROSARCOMA RNA SYNTHESIS BY BOVINE GROWTH HORMONE. M.E.Bembenek* and J.P. Liberti*, Dept. of Biochem., Med. Col. of VA, Richmond, VA 23298.

Recent information suggests that the N-terminal region of the growth hormone (GH) molecule displays many of the metabolic actions associated with the native hormone (GH 1-191). A specific GH fragment, GH 96-133, termed AII, stimulates adipose and liver tissue metabolism. In the present study rat chondrosarcoma was used as the test system because cartilage is the most responsive tissue to GH in vivo. Chondrocytes were isolated from tumor minces after brief exposure to .2% collagenase at 37°. Preliminary studies showed that reproducible results were obtained using $1-2\times10^5$ cells/ml ± test substances in 1 ml modified culture medium at 37°. 1 μCi ^{3}H-uridine was present for 2 h intervals prior to stopping the reaction. Radioactivity of acid-precipitates (^{3}H-RNA) was determined in quadruplicate samples and quench corrected. Chondrocytes were exquisitely sensitive to AII; as little as 10^{-9} M fragment stimulated RNA synthesis (p<.01). Surprisingly GH (1-191) also enhanced RNA synthesis; 4×10^{-10}M stimulated 34% above control levels. These results indicate that mammalian chondrocytes may be a valuable in vitro system to investigate the metabolic actions of GH fragments with the aim of learning about structure:activity relationships.

HUMAN STRESS ANALYSIS FOR BIO-MEDICAL PROBLEMS AND PSYCHO-SOMATIC MEDICINE. John C. Bartone, Michael P. Kradz, Brenda M. Reynolds* and Mary Rebecca Bartone*, The American Health Research Institute, Annandale, Virginia 22003.

The American Psychiatric Association, with its *Diagnostic and Statistical Manual of Mental Disorders (DSM-II (1968), DSM-III (1977))*, and the American Psychological Association with its Task Force on *Descriptive Behavioral Classification*, present discordant discountenance on the classification, understanding and treatment of the illnesses of mankind. While DSM-II is "the foremost classification system for emotional and behavioral disorders (Woody, 1980), the APA Task Force prefers a less disease-oriented model, as one of entire patient ecology. DSM-III changes are insufficient. Diagnoses of etiology are critical for both systems and hence the importance of nosology. Also at stake are idiographic versus nomothetic methods for clinical assessment of patients' complaints and disorders as well as attitudinal dispositions and care.

Both systems and all aspects of human illnesses and endeavors contain large reservoirs of *undifferentiated* stress of great complexity which creates expanding psychosomatic conditions and diseases, behavioral distortions and personality derangements.

A third system is proposed for stress analyses which dissects stress into rational compartments for clinical assessment, treatment and resolution. Stress can no longer be treated as a single entity. Its myriaded specificities do ramify every life. Behavior and disease require its dissection.

EFFECT OF GOLD THIOGLUCOSE TREATMENT ON THE MOUSE PANCREAS. G. R. Bryson, J. E. Jeffrey, and S. R. Webb. Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23284

Gold thioglucose (GTG) will preferentially destroy the cells of the ventromedial hypothalmus (VMH). This results in release of inhibition by the VMH - sympathetic system on insulin secretion from the beta (B) cells of the pancreas. Continued stimulation via the lateral hypothalamus (LA) - parasympathetic system can then occur and result in obesity, hyperinsulinemia and B cell proliferation.

Male mice of the strains C57Bl/6J and SWR/J were given ip injections of GTG (1.6, 0.8, or 0.4 mg/g body wt.) to determine if the treatment would induce B cell proliferation and provide a greater B cell mass. C57Bl/6J mice were resistant to the toxic and VMH effects of GTG treatment at all dosage levels. SWR/J mice, on the other hand, were more susceptible to its toxic effects with mortalities of 88%, 50% and 10% for doses of 1.6, 0.8 and 0.4 mg/g, respectively. VMH lesions were confirmed in obese SWR/J survivors. These mice had transient hyperglycemia and glucose intolerance. After glycemia and body weight had stabilized the pancreases were found to have larger islets due to an increase in B cells.

This technique represents one method of increasing the B cell mass of the pancreas for studies on isolated islets or their cultured B cells, but it is not expeditious, uniform between animal strains, or cost effective.

(Supported by NIH grant R01-AM21730)

A STUDY OF NUCLEUS RAPHE MAGNUS AFFERENTS IN THE RAT USING THE HORSERADISH PEROXIDASE TECHNIQUE AND TETRAMETHYLBENZIDINE NEUROHISTOCHEMISTRY. Susan M. Carlton*, Eric G. Young* and George R. Leichnetz*. Dept. of Anatomy, Med. Col. of Va. Commonwealth Univ., Richmond, Va., 23298.

Since the nucleus raphe magnus (NRM) plays an important role in a descending pain-inhibiting system through its projections to the spinal trigeminal complex and spinal cord dorsal horn, defining its afferent systems became essential in order to identify other CNS nuclei which could potentially influence analgesic mechanisms by virtue of their connections with NRM. Accordingly, horseradish peroxidase (HRP) gel implants or fluid HRP injections were made within NRM and in adjacent areas (through previously implanted stainless steel cannulae) in 11 adult male albino rats. Those nuclei which were consistently labelled with retrogradely-transported HRP include the thalamic parafascicular nucleus (PR), zona incerta (ZI), dorsal and lateral periaqueductal gray (PAG), the deep layers of the superior colliculus (DSC), nucleus cuniceformis (NC), and a cell group in the ventral PAG which appears to be continuous with the nucleus of Darkschewitsch (ND). Control spinal cord HRP gel implants demonstrated that the ZI, DSC, and ND also project to the spinal cord, and thus the possible involvement of axons of passage originating from these nuclei and passing through NRM must be considered. However, the heavy and consistent labelling of the PF, PAG, and NC strongly suggests that these nuclei constitute part of the repertoire of NRM afferents.

BOVINE GROWTH HORMONE FRAGMENT 1-133:CHARACTERIZATION AND SOMATOMEDIN-LIKE ACTIVITY. L.A.Durham III* and J.P.Liberti*, Dept. of Biochemistry, MCV/VCU, Richmond, VA 23298.

The somatomedins(SMs) are a family of low mol. wt. peptides which are thought to mediate many biological actions of growth hormone (GH). In addition to other activities, the SMs stimulate in vitro sulfation and DNA synthesis of cartilage tissue. Little is known at the molecular level regarding the in vivo production of SM although it's clear that GH is involved in some way. Recent indirect evidence suggests that GH is cleaved endogenously to produce SM activity. To examine this possibility directly, GH was digested with thrombin for 30 h at 37°. The reaction products were reduced and carbamidomethylated prior to separation by Sephadex gel filtration at room temperature. Two products were obtained and identified as GH (1-133) and GH (134-191) by SDS-gel electrophoresis and amino acid and N-terminal analyses. GH (1-133) at 10^{-10} M significantly stimulated $^{35}SO_4$ uptake and [^{3}H-methyl]thymidine incorporation into DNA of hypox rat costal cartilage in vitro. GH (134-191) had slight activity which may be due to GH (1-133) contamination. Native GH (1-191) had little stimulatory activity. These data clearly show that SM activity can be derived from the native GH molecule which is devoid of such activity and suggest that in vivo production of SM activity may arise via specific proteolytic cleavage of the GH molecule.

CHARACTERIZATION OF PLASMA ZINC BINDING PROTEINS IN FAMILIAL HYPERZINCEMIA. M. L. Failla and M. van de Veerdonk*. Department of Biochemistry & Nutrition, Virginia Tech, Blacksburg, VA 24061.

In 1976 Smith and associates reported the presence of extremely high plasma concentrations of zinc in 5 of 7 members of one family and 2 of 3 second-generation individuals (Science 193, 496). Moreover, they demonstrated that familial hyperzincemia (HZ) was not due to toxic ingestion or contamination, nor was it associated with health problems. The present studies were undertaken to compare the distribution of plasma zinc in normal (N; < 1.0 μg Zn/ml) and HZ (> 3 μg Zn/ml) individuals. N and HZ plasma Zn quantitatively eluted from Sephadex G100 with molecular weight species > 100,000 (α 2 macroglobin) and 60-80,000 daltons. The additional complement of Zn in HZ plasma was present in the second peak. Potential zinc-binding entities of this size include albumin (Al), transferrin (Tf), and histidine-risk glycoprotein (HRG), and perhaps an uncharacterized protein in HZ individuals. That zinc was not associated with Tf was ascertained by affi-gel affinity chromatography. Anti-human IgG was bound to Protein A-Sepharose and peak II material applied. Zinc and Al were quantitatively bound to the antibody-containing matrix. These results demonstrate that additional quantity of zinc in HZ plasma is associated with one or more albumin-like species. The biochemical basis for enhanced binding is being investigated. (Supported by NIH AM 20420)

PRELIMINARY RESULTS IN DETECTION OF LEVELS OF PROTEIN NUTRITION BY SPECTROPHOTOMETRIC DIFFERENCES IN BLOOD PLASMA OF RATS. G. Colmano and S. S. Edwards, VPI & SU, College of Veterinary Medicine, Division of Veterinary Biology, Blacksburg, VA 24061

Preliminary analysis of absorption spectra scans of blood plasma on three levels of protein nutrition (4%, 15%, and 40% casein), comparing the absorbances of dipeptide bonds (190 nm), aromatic amino acid residues (278 nm), hemoproteins (414 nm and the 452-578 nm difference for bilirubin), ceruloplasmin (278/610 nm), and oxidized ascorbic acid (630/278 nm), indicate that as long as the animals remain healthy the blood system is strongly homeostatic and is not basically changed in its protein composition, even by strong variations in levels of protein nutrition. A statictical analysis is in progress on the correlation of blood plasma absorption peaks of rats on three levels of protein nutrition, superimposed stress and added bacterial infections. Rats (corticosterone producers) and hamsters (cortisol producers) are under study for spectral absorbance changes, physiological changes, and pathological changes. The digitized spectra and other pertinent data are now being stored in a repository library for further computer analysis.

SPECTROPHOTOMETRIC ABSORBANCE DETECTION OF LOW LEVELS OF LEAD IN BLOOD PLASMA OF RATS. S. S. Edwards and G. Colmano, VPI & SU, College of Veterinary Medicine, Division of Veterinary Biology, Blacksburg, VA 24061

Absorption spectra scans of blood plasma from mice and quail with lead poisoning indicated differences in major absorption peaks of protein at 190nm (dipeptide bonds) and 278 nm (aromatic amino acid residues). In a preliminary experiment we established from absorption spectra of blood plasma some limits at which the lead in the diet affected the balance of proteins. We used 21 day old male rats and fed 2 animals 5ppm and 2 animals 10 ppm of lead in their feed. Three control animals were fed normal rat chow. The following table shows levels of lead consumed in 24 days compared with major absorption peaks found in blood plasma.

Days on Pb	No. of Animals	5 ppm Expt. g Pb × 10^{-6} ml^{-1} blood plasma	Major Absorption Peaks (nm)			No. of Animals	10 ppm Expt. g Pb × 10^{-6} ml^{-1} blood plasma	Major Absorption Peaks (nm)		
			190	278	190/278			190	278	190/278
0	2	—	5086	52.70	96.51	2	—	5198	52.65	98.73
9	2	3.98	4718	51.40	91.79	2	8.25	4934	54.00	91.37
18	2	6.24	5875	65.75	89.35	2	13.15	6278	74.05	84.78
24	2	7.32	6263	75.50	82.95	2	14.91	6558	63.25	79.73

ACUTE TOXICITY AND BEHAVIORAL ACTIVITY OF PHENCYCLIDINE AND ITS PYROLYTIC PRODUCTS, PHENYLCYCLOHEXENE AND PIPERIDINE, IN MICE. A.S. Freeman* and B.R. Martin. Dept. of Pharmacol., Med. Col. of Va., Richmond, VA 23298.

Previously, we reported that phencyclidine (PCP) is partially pyrolyzed to phenylcyclohex-1-ene (PC) when it is smoked. The presence of piperidine in mainstream smoke has now been detected by 1) thin-layer chromatography of condensates generated from the smoke of (^{3}H-piperidyl)-PCP-containing cigarettes and 2) gas chromatography-mass spectrometry of smoke condensates. The acute toxicities of PCP, PC and piperidine in mice were assessed by determining their LD50's following intravenous injection. The LD50's (μmoles/kg, confidence limits) were 56 (53-61) for PCP, 576 (534-621) for piperidine and 447 (428-467) for PC. The effects of these compounds on motor coordination were assessed by the inverted screen test. The ED50's (μmoles/kg, confidence limits) for inhibition of completion of the task were determined immediately following intravenous injection. PCP (4.1, 3-5.1) was most effective, followed by piperidine (221, 185-266) and PC (325, 294-360). The effects of piperidine and PC had disappeared within 5 min., whereas those of PCP lasted approximately 25 min. It is concluded that PC and piperidine contribute little to the acute lethal or incoordinating effects of smoked PCP. (Supported by U.S.P.H.S. grant no. DA-02396).

GLUCOSE-INDUCED INSULIN SECRETION FROM ISOLATED HAMSTER ISLETS. M. Griffis, P. E. Giebel, G. R. Bryson, and S. R. Webb, Dept. of Biology, VA. Commonwealth University, Richmond, VA 23284.

Stimulus-induced insulin secretion from the beta cells of pancreatic islets has traditionally been examined using intact animals or by perifusion of the functionally isolated pancreas. The development of methods to isolate physiologically viable islets has contributed to a renewed interest in factors that affect secretion by the islet cells which are removed from other influences of the animal.

Islets were isolated from the pancreases of Golden Syrian Hamsters and their response to stimulation with glucose was evaluated. Islets were isolated using established collagenase digestion and ficoll gradient techniques and were transferred (75-100/assay) to a perifusion chamber equipped with a 2.5 um filter; the islets were free of acinar tissue. Chambers were perfused at 0.6 ml/min with glucose at concentrations of 0, 2.5, 5.6, and 22.2mM. An immediate peak of insulin secretion occured after sequential stimulation at each glucose concentration. After each peak insulin secretion was maintained at a level above the previous lower concentration. Upon return from 22.2mM to 0mM glucose there occured an unexpected and large peak in insulin secretion. This preliminary study provides baseline data for studies on factors affecting hormone secretion by islets. (Supported by NIH Grant R01-AM21730)

EFFECT OF TIME AND TEMPERATURE ON POST-MORTEM CHANGES IN CORNEAL EPITHELIAL GLYCOGEN LEVELS. T.M. Harris, E.R. Berry, and L.B. Sheppard*. Department of Anatomy, Medical College of Virginia, Richmond, Virginia 23298.

Glycogen levels in corneal epithelium are sensitive indicators of the corneal vitality and are related to the success rate of keratoplasty. Epithelial glycogen stores are quickly depleted in response to stress, anoxia and various storage conditions (Thoft & Friend, 1976).

Harris, Berry, and Sheppard (1981) reported a new technique for the study of corneal epithelial glycogen. The technique utilizes micro-electrophoresis in agarose gel and permits the quantitative analysis of the glycogen from approximately 1/4 of a single human cornea. Using this procedure the time-temperature kinetics of glycogen disappearance from rabbit corneal epithelial extract was studied. Glycogen disappeared at a rate of 54.9%/hr. at 10°C, 16.1%/hr. at 6.5°c and 5.7%/hr. at 2°c.

In recent preliminary studies it was shown that demonstrable glycogen levels are totally depleted from rabbit eyes left in situ after death at room temperature for four hours; a trace was present at three hours and approximately 50% was present after two hours. The results of other preliminary studies involving various storage conditions at different temperatures will be commented on briefly.

SHORT-TERM ALTERATIONS IN TRACE METAL STATUS IN THE STREPTOZOTOCIN-DIABETIC RAT. R. F. Kiser* and M. L. Failla Department of Biochemistry & Nutrition, Virginia Tech, Blacksburg, VA 24061.

Male Sprague-Dawley rats were injected ip with streptozotocin (STZ) to induce the diabetic condition. At 0, 1, 2, 4, 7, 14, 21 and 28 days, the level of Zn, Cu, Mn and Fe was quantitated in liver, kidney, duodenum and testes. Renal Zn and hepatic Mn content were significantly elevated in diabetic rat relative to controls by 2 days after STZ injection. Similarly, by 7 days the Zn content of liver and testes and Cu level of liver and kidney were significantly increased. The degree of accumulation of the metals in indicated tissues was proportional to the duration of the diabetic state. Elevated levels of hepatic and renal metallothionein, a soluble, heavy metal binding protein, were also observed as early as 24-48 hours post-injection. Additional alterations in the cytosol distribution of Zn and Cu in liver and kidney were also found to be time-dependent. The potential role of short-term trace metal fluxes in the biochemical adaptions to the diabetic state, as well as the potential secondary complications resulting from heavy metal accumulation in insulin-dependent diabetes, will be discussed. (Supported by USDA Competitive Grant and J. L. Pratt Animal Nutrition Program)

THE MECHANISM OF ASBESTOS-INDUCED CARCINOGENESIS: CALCIUM AND PLASMA MEMBRANE INTEGRITY, J. H. Guth, Ph. D., Interscience Research, Inc., 2614 Wyoming Ave., Norfolk, VA 23513.

The major properties determining carcinogenic potential of asbestos fibers, are their size and shape. The chemical composition has minimal relevance. The initial cellular interaction is the partial or complete phagocytic uptake of fibers of appropriate sizes. Phagocytotically-active cell-types, such as macrophages, appear to be the most sensitive. The most carcinogenic fiber size is approximately 1.25 X 3.75 microns or longer. Cell impalement, where the fiber is not completely taken into the cell, or has penetrated the membrane mechanically, seems to be the initial damaging event. Within 36 hours after application of asbestos fibers, gross karyological abnormalities appear. Polyploidy and chromosome breakage have been observed which must lead to mutagenesis and ultimately, carcinogenesis. All of these results are predictable from what is known about the capabilities, compartmentation, and management of the calcium ion in mammalian cells. Allowing excess Ca^{++} to leak into the cytosol is known to(1)cause abnormal chromosomal condensation,(2)activate the mitotic spindle contraction and mitotic cleavage off-schedule, and(3)modulate the phosphorylation of histones, and thus gene readout. A leaky plasma membrane and a disturbance in Ca^{++} levels can bring together all major observations on asbestos carcinogenesis into a unified theory.

OPIATE ANALGESIA TESTING IN RABBITS: EVIDENCE FOR THE RELEASE OF ENDOGENOUS OPIATES. Dennis E. Jones*, Agneta Ohlsson* and William L. Dewey. Dept. of Pharmacol., Med. Col. of Va., Richmond, VA 23298

Our previous data in mice have shown that the analgesic effect of exogenously administered morphine sulfate (MSO_4) may be mediated through release of endogenous opioid substances into the cerebrospinal fluid (CSF). In order to investigate this more fully, we developed an analgesic rabbit model which allowed withdrawal of sufficient quantities of CSF for assay of opioid activity. A cutaneous skin twitch assay was developed in which the spinal reflex mediated contraction of the cutaneous musculature in response to an external thermal stimulus was measured. A dose dependent inhibition of this response was seen following injection of MSO_4. CSF was withdrawn via cisternal spinal tap at the peak of analgesic activity. This CSF, added to the tissue bath of electrically stimulated guinea pig ileum (an opiate bioassay), was found to inhibit contractions in a dose dependent manner similar to the inhibition produced by opiates. This inhibition was reversible by naloxone. Such activity was absent in the CSF of saline treated rabbits. Experiments with radiolabeled morphine have shown that this inhibitory activity is not due to either morphine or its metabolites in the CSF. These experiments in rabbits confirm our previous results in mice. (Supported by U.S.P.H.S. Grant #DA-01647).

VASCULAR RESPONSIVENESS OF THE PREGNANT RAT TO ANGIOTENSIN II. M.E. LaVecchia* and J.L. Hart Biology Dept. George Mason University, Fairfax, Va. 22030

Systemic arterial blood pressure (BP) responses of pentobarbital anesthetized non-pregnant(estrus) (NP) rats and rats at 3 stages of pregnancy(7-8,11-13,&18-19 days) to angiotensin II(AII)(32,320,640 ng/kg)injections were recorded. Dose-related increases in BP occurred in all groups; however analysis of variance indicated that the pressor responses to AII were significantly less(p<.05)in late pregnant rats than in NP rats. This confirms previous reports of decreased pressor responses to AII during pregnancy.

In order to determine if decreased blood vessel responsiveness plays a role in the diminished pressor activity of AII in the intact rat, isolated aortic strips and femoral artery cylinders from NP and late pregnant(P) rats were studied. Isometric tension of these vessels was recorded while they were in 37°C oxygenated Krebs-filled tissue baths. After 90 min equilibration, cumulative dose-response curves to AII($3x10^{-12},3x10^{-8},3x10^{-6}M$) were done. Tension development of aortic strips from P rats was significantly greater than that from NP rats.Maximum tension of femoral arteries from P and NP was not different. These results do not support the hypothesis that decreased blood vessel responsiveness contributes to the diminished pressor activity of AII in the pregnant intact rat.
(Supported by GMU CRAS Grant # 2-100035)

GLYCOGEN CHANGES IN MUSCLE TRANSPLANTS AFTER VARIOUS TREAT-MENTS. F.S.F. Mong, and J.L. Poland, Depts. of Anatomy and Physiology, Med. Coll. Va., Richmond, Va. 23298.

Since free muscle transplantation has been successful in animals and in humans, it is important to understand some basic properties before further clinical application is undertaken. The present study compared glycogen changes in transplanted and normal muscles following exercise or fasting. Male Sprague-Dawley rats (120 gm. wt.) were used. The extensor digitorum longus (EDL) and soleus (SOL) muscles were removed, switched to each other's muscle bed and sutured to the tendon stumps left in situ (thus, the EDL muscle became the SOL-transplant, and vice versa). Fifty days later, half of the rats ran for 30 mins (1 mph) on a treadmill (having been trained previously for 1 week) and were sacrificed either immediately or 4 hrs after the exercise. The other half of the rats were fasted for 48 hrs and then sacrificed either at the end of the fasting period or after being refed for 4 hrs. Glycogen levels were determined in the EDL-transplants, SOL-transplants, and contralateral EDL & SOL muscles from these experimental and control rats. Glycogen concentration in the transplants decreased 30 to 60% as did the glycogen of contralateral normal muscle either immediately after exercise or after 48 hrs of fasting. Glycogen repletion after either exercise or with refeeding was similar yet more complete in normal muscle than in transplants after 4 hrs. It is concluded that with exercise or fasting glycogen in transplants changes in a similar manner to that in normal muscle. (Supported by Muscular Dystrophy Assoc. & MCV Grant-in-Aid).

INTESTINAL ABSORPTION OF COPPER AND ZINC IN THE STREPTOZO-TOCIN-DIABETIC (STZ) RAT. S. P. Osborne* and M. L. Failla. Department of Biochemistry & Nutrition, Virginia Tech, Blacksburg, VA 24061.

We have recently found significantly elevated levels of Cu and Zn in livers and kidneys of STZ rats. These alterations in tissue trace metal levels were shown to be due to the hormonal imbalance characterizing the diabetic condition. The present studies were undertaken to determine if the increased complement of tissue Cu and Zn was due in part to increased intestinal absorption of these metals. Control and STZ rats were administered either ^{64}Cu or ^{65}Zn by stomach tube, given free access to chow and water and sacrificed at 22 hr. STZ rats absorbed 35 and 66% of the ^{64}Cu and ^{65}Zn, respectively. Controls absorbed 28% ^{64}Cu and 61% ^{65}Zn doses. Since STZ rats (2 weeks after injection) consume twice as much diet/day/kg body wt as controls, the results suggested that STZ rats were absorbing twice as much dietary Cu and Zn as controls. This was confirmed by feeding ^{64}Cu and ^{65}Zn-labeled purified diets. These data, as well as the quantity of metallothionein in intestinal mucosa in control and STZ rats, suggest that homeostatic control of Cu and Zn absorption is impaired in the STZ-diabetic rat. (Supported by USDA Competitive Grants and J. L. Pratt Animal Nutrition Programs).

COMPUTER SIMULATION OF A PROPOSED MODEL OF CALCIUM UPTAKE IN SARCOPLASMIC RETICULUM. S. Rapundalo* and J. Feher*, Dept. of Physiology, Med. College of Va., Richmond, Va. 23298

Several reaction schemes have been proposed to explain the coupling of calcium (Ca) transport with ATP hydrolysis in skeletal sarcoplasmic reticulum (SR). We attempted to evaluate a specific reaction scheme (Ca-ADP-Ca order of release) by using the electronic simulation program SPICE2. Previous attempts at simulating these schemes have suffered from either a lack of flexibility or difficulty in their mathematical formulation. The reaction scheme we evaluated explained some transient- and steady-state behavior of intact SR. The amounts of Ca translocated during the transient state reached 6-8 nmol/mg SR protein. Liberation of P_i exhibited an initial lag phase, which coincided with the rapid increase in total phosphoenzyme formation. Simulations show that the initial burst of Ca uptake corresponds to Ca desorbed from the enzyme. However, addition of EGTA+ADP did not have much effect on transient-state kinetics suggesting a qualitative error in the scheme. Steady-state uptake of Ca reached 104 nmol/mg protein in 1.5 min. Passive Ca efflux was accurately predicted by the simulation. However, the reaction scheme we evaluated lacks the correct Ca dependency. We were able to simulate ionophore-induced Ca release and obtained a concomitant rise in ATPase rate. Using simple network simulation techniques we have, for the first time, been able to evaluate transient- and steady-state behavior for a defined reaction scheme having a Ca-ADP-Ca order of release.

GLYCOSYLATED HEMOGLOBIN (HbA1) LEVELS IN MICE RECOVERING FROM EXPERIMENTAL DIABETES AFTER PANCREATIC ISLET TRANSPLANTATION. K. M. Morrison* and R. C. Kramp. Dept. of Biology, Va. Polytechnic Inst., Blacksburg, Va. 24061

Glycosylated hemoglobin (HbA1) is a modified hemoglobin molecule in which glucose becomes attached to the β chains. Normally present in blood cells in small quantities (6-8%), it becomes elevated 2-to 3-fold in diabetics. Since the glycosylation is a slow, nonenzymatic process, high plasma glucose of diabetics results in elevated HbA1. Assays for HbA1 are becoming clinically accepted as an objective, quantitative index of plasma glucose control in diabetics. Our study showed that streptozotocin diabetic mice recovered from hyperglycemia after isogeneic, subcutaneous transplantation of duct-ligated pancreas, but still showed impaired tolerance to an oral glucose load (3.0g/Kg mouse). However, HbA1 levels in diabetic mice (4.09 ± 0.23%) returned to normal (2.84 ± 0.05% vs 2.57 ± 0.05% in normals) within 9 weeks after transplantation or 3 weeks after recovery from hyperglycemia. Thus, transplant recipients maintain normal glucose homeostasis under normal feeding conditions.

CORRELATION BETWEEN NICOTINE BRAIN LEVELS AND BEHAVIORAL ACTIVITY IN RATS. L. Palmer*, H.L. Tripathi*, R. Brosius*, M.D. Aceto* and B.R. Martin. Dept. of Pharmacol., Med. Col. of Va., Richmond, VA 23298.

When nicotine (1 mg/kg) is injected s.c. into male Sprague-Dawley rats, it produces maximum antinociception (tail-flick response) at 2 min. and only 10% antinociception at 10 min. Rats were also injected s.c. with ^{3}H-nicotine (1 mg/kg) so that the time-course of ^{3}H-nicotine in brain and plasma could be determined. Maximum brain and plasma levels (mean + S.E.) occurred at 10 min. (1.24 + .06 ng/mg) and 0.27 + .0T ng/µl, respectively) and fell gradually over the next 50 min. Lack of correlation between antinociception and brain levels of nicotine led to the investigation of other central effects of nicotine. Rats treated with nicotine (1.5 mg/kg, s.c.) were tested in an open field for spontaneous activity and on a rotarod for motor coordination. Maximum effect in both tests (90% and 48% of control, respectively) occurred at 10 min. and returned to control levels within 60 min. for spontaneous activity and 35 min. for rotarod activity. The brain levels of nicotine correlate well with nicotine's effects on spontaneous activity and motor coordination but not with its antinociceptive effects. The short time course of antinociceptive action may be due to a rapid development of tachyphylaxis which is not seen with the other effects of nicotine. (Supported by U.S.P.H.S. grant no. DA-02384).

VITAMIN A, ZINC, AND RETINOL-BINDING PROTEIN IN BURN PATIENTS. M. Riggle*, R.B. Brandt and W. Chan. Department of Biochemistry, Medical College of VA, Richmond, VA 23298

Vitamin A is essential for normal growth, vision, and reproduction. It is also important in epithelial maintenance and differentiation and in providing immunity from infection. Following trauma, plasma levels of vitamin A decrease. In view of the widespread role of vitamin A in multiple biochemical processes it is important to determine the interrelations between vitamin A and the components involved in its transport in trauma states. This study examined the effect of burns in humans on plasma levels of vitamin A, its carrier protein, retinol-binding protein (RBP), albumin, total protein, and zinc.

Plasma vitamin A levels decreased 29%-77% as a function of the severity of the burn. Zinc and RBP levels also decreased 17%-42% and 38%-60%, respectively. The level of total protein however remained normal. This suggests that the decrease in the carrier protein is a selective one. The data supports the hypothesis that vitamin A levels decrease due to impaired mobilization from the liver and is also consistant with zinc acting as a regulatory factor in the synthesis or activation of the transport protein. (Supported by funds from NFCR)

EFFECTS OF POLYCHLORINATED BIPHENYLS ON SYNAPTOSOMAL AND MITOCHONDRIAL ATPASES FROM MOUSE BRAIN. D.L. Rosin* and B.R. Martin. Dept. of Pharmacology, Med. Col. of Va., Richmond, VA 23298

We have previously reported that polychlorinated biphenyls (PCBs) alter central neurotransmitter function in vitro at concentrations of 10^{-6} to 10^{-4} M. In the present studies the activity of ATPases from isolated mouse brain synaptosomes and mitochondria was evaluated by means of a coupled-enzyme ATP-regenerating system. A linear relationship between enzyme concentration and rate of ATP hydrolysis was demonstrated. Ouabain, a specific Na^+/K^+-ATPase inhibitor, produced maximal inhibition at a concentration of 1 mM. The mitochondrial Mg^{2+}-ATPase inhibitor, oligomycin, inhibited activity maximally at 10^{-7} M. Addition of PCBs (Aroclor 1254) to these systems in vitro inhibited both synaptosomal (Na^+/K^+- and Mg^{2+}-ATPases) and mitochondrial (oligomycin-sensitive and insensitive ATPases) enzyme activity with IC50 values for PCBs of approximately 10^{-4} and 5×10^{-6} M, respectively. Varying the time of incubation of enzyme with 10^{-5} M PCBs (1, 2, 5, 10, 15, 30 and 60 min.) produced little change in degree of inhibition. In addition, ATPase activity was not altered in mitochondria and synaptosomes isolated from mice 45 min. following oral administration of PCBs at 50, 100, 250 or 500 mg/kg. These in vitro inhibitory effects on neuronal ATPases are consistent with our previous findings that PCBs enhance neurotransmitter release. (Supported by NIH Training Grant 5-T32-ES07087-03).

METALLOTHIONEIN IN LIVER PARENCHYMAL AND NON-PARENCHYMAL CELLS:QUANTITATION AND POSSIBLE PHYSIOLOGICAL ROLES. C. V. Sciortino*, B. Bullis* and M. L. Failla. Department of Biochemistry and Nutrition, Virginia Tech, Blacksburg, VA 24061.

Metallothionein (MT), a low molecular weight, intracellular heavy-metal binding protein, has been shown to be elevated in liver of rats (1) injected with zinc or cadmium salts, (2) treated with endotoxin and (3) exposed to environmental stresses. The presence and role of MT in various liver cell types has not been previously studied. Liver parenchymal cells (PC) were isolated by differential centrifugation following perfusion with collagenase. Nonparenchymal cells (NPC) were isolated by a gentle, non-digestive, gravimetric speration technique that yielded 95-98% viable cells with < 0.2% parenchymal cell contamination. MT levels in PC and NPC cytosol were quantitatively determined by competitive ^{203}Hg binding assay followed by gel filtration chromatography. Both PC and NPC synthesize MT, although the basal level per mg cytosol protein is greater in the former than the latter. Administration of Zn and Cd salts significantly elevated the MT level in both cell populations. However, fasting only resulted in induction of PC MT biosynthesis. (Supported by NIH AM 363941).

ULTRASTRUCTURE OF BLOOD VESSELS GROWING WITHOUT MITOSIS INTO IRRADIATED CORNEAS. M.M. Sholley*, J.D. Wilson*, H.R. Seibel, and J.L. Montour*. Depts. of Anatomy and Radiology, Med. Col. of Va., Richmond, Va. 23298.

Our previous studies of neovascularization in irradiated corneas revealed that substantial early formation of new vessels occurs despite severe inhibition of endothelial cellular proliferation. We have now performed ultrastructural studies to elucidate the cellular mechanisms permitting persistent neovascularization. The left eyes of rats were irradiated with 1000, 2000 and 8000 rads of 45 kVp X-rays. Then both corneas were cauterized with $AgNO_3$ to induce vascular ingrowth. Corneas were fixed by perfusion at 2 and 4 days. At 2 days, sprouts projected from limbal vessels into control and irradiated corneas. In controls, mitoses were sometimes seen in endothelial cells (EC) at the tips of sprouts and in less advanced EC; no mitoses were observed after irradiation. In control and irradiated corneas, EC were hypertrophic and contained abundant rough ER and free ribosomes. Similar EC hypertrophy and increased organelles were present at 4 days. Also, the orientation of many EC suggested migratory activity. Numerous EC had pseudopods extending toward the lesion; and the vascular wall was often 2 or 3 cells thick near the tips of sprouts, with luminal extensions between overlapping EC. In irradiated corneas some EC contained several small nuclei, perhaps indicating abortive mitosis. Thus, it appears that EC hypertrophy and migration can operate without mitosis to yield considerable early vascular growth. (Aided by NIH Grant CA-26316).

A COMPARISON OF THE EFFECTS OF DIANABOL AND METHYLTESTOSTERONE ON MUSCLE CONTRACTION AND FATIGUE. S. Smith*, J. H. Richardson. Dept. of Biology, Old Dominion Univ., Norfolk, Va. 23508

The purpose of this study was to determine whether or not Dianabol (methandrostenolone), an anabolic steroid, was effective in increasing muscular strength and stamina. Studies done in the past have not provided accurate results, due to their research techniques. The technique in this study is highly accurate for measuring muscle strength and stamina. Thirty white rats were used. Ten served as control animals. Ten were given a daily dose of .35 mg/kg/day of Dianabol for 30 days. The remaining ten received a daily dose of .35 mg/kg/day of methyltestosterone. Strength of contraction of the muscle and fatigue time were measured on the physiograph. Results indicate that contraction strength and contraction time for the Dianabol group were not significantly longer than for control animals. However, the testosterone animals showed significantly stronger contractions and increased stamina over the other two groups. This study suggests that Dianabol does not increase strength or stamina.

THE IDENTIFICATION OF A NEW PHENCYCLIDINE ANALOG, 1-(1-PHENYLCYCLOHEXYL)-4-METHYLPIPERIDINE, AS A DRUG OF ABUSE. W. H. Soine[1], R. L. Balster[2], K. E. Berglund[3]*, C. D. Martin[3]* and D. T. Agee[3]*. [1]Dept. of Pharmaceutical Chemistry, [2]Dept. of Pharmacology, Med. Coll. of Va. and [3]Drug Examination Section, Bureau of Forensic Science, Dept. General Services, Richmond, Va. 23298.

A previously unreported phencyclidine(PCP) analog, 1-(1-phenylcyclohexyl)-4-methylpiperidine(I), in which the piperidine ring has been substituted with 4-methylpiperidine, has been observed to be an abused drug in Virginia. I was obtained coated over parsley in an approximate concentration of 1.7%(w/w).I·HCl was isolated, purified and compared to authentic I·HCl (sample obtained from DEA and synthesized in the laboratory) using melting point, IR, ^{1}H-NMR, GC and GC/MS. Unequivocal identification of I·HCl was based on its ^{13}C-NMR. The intraperitoneal LD_{50} of I·HCl in male mice was 301.1 umoles/kg(267.1-339.3,95% confidence limits) and the ED_{50} was 45.0 umoles/kg(37.2-54.2). The therapeutic index, LD_{50}/ED_{50}, for I·HCl was 6.7 and is much lower than that observed with phencyclidine, 38.1. Two additional nitrogen containing compounds were isolated and identified using only GC/MS. These contaminants were phencyclidine and N-cyclohexyl-4-methylpiperidine, and were present in extremely low concentrations. (Aided by NIDA grant DA-01442 and-07027)

PREFERENTIAL BINDING OF CHLORDECONE (CD) BY PROTEINS AND HDL IN PLASMA, P. J. Soine, R. V. Blanke, (Dept. Pathol.) and P. S. Guzelian, C. C. Schwartz (Dept. Med.), (Med. Coll. Va., Richmond, VA. 23298).

Preferential distribution of the pesticide, CD, to liver rather than to fat tissues in man suggests that this relatively nonpolar pesticide may be transported in plasma in a manner different from other organochlorine pesticides. Plasma binding of ^{14}C-CD was investigated in vitro, in human, rat and pig plasma and in vivo in rat plasma. In human plasma, the distribution of CD among proteins, HDL, LDL and VLDL was 46%, 30%, 20% and 6% when separated by serial ultracentrifugation. The distribution of cholesterol in the same plasma fractions was 4%, 20%, 63% and 7%. In pig and rat the order of binding was similar to man with CD binding to protein≥HDL>LDL≥VLDL. Separation of CD plasma fractions by Hep-Mn Ppt and agarose gel electrophoresis (AGE) confirmed the results obtained by ultracentrifugation. The distribution of CD in rat lipoproteins was similar whether the CD was administered in vivo or incubated with plasma in vitro, with 80%, 11% and 9% bound to HDL, LDL and VLDL in either case. AGE of plasma bound CD showed that albumin was the major component of the protein fraction responsible for CD binding. Preferential binding of CD by albumin and HDL may explain its unusual tissue distribution when compared to other organochlorine pesticides such as aldrin and dieldrin which bind preferentially to VLDL and LDL and distribute preferentially to fat tissues. (Supported by USPHS AM29520 and NIEHS R01ES01519 grants.)

MORPHOLOGICAL AND PEROXIDASE CHARACTERISTICS OF ANTIGENICALLY DISTINCT IMMATURE AND MATURE MACROPHAGES. A.K. Szakal*, J.R. Yannelli*, Department of Anatomy, Medical College of Virginia, Richmond, Virginia 23298.

Thioglycollate elicited Balb/c peritoneal macrophages (MØ) were studied in vitro using macrophage-specific antiserum in conjunction with F[ab']$_2$ conjugates (FITC and ferritin) and peroxidase (PO) cytochemistry to identify immature and mature MØ's. In 24 hr and 96 hr MØ cultures 100% of the cells fluoresced after incubation with anti-macrophage serum (APMS-24) and FITC conjugate. After absorption of APMS-24 with mature MØs from 96 or 120 hr cultures, 58+14 percent of the cells in 24 hr cultures and only 1-2% of the cells in 120 hr cultures fluoresced. This paralleled the reduction in the number of PO+ cells in cultures between 24 hrs and 120 hrs (56+2% to 1.3+0.6%). When 24 hr cultures were incubated with mature MØ absorbed APMS-24 and ferritin conjugate and treated subsequently for PO activity the cells with PO reactivity in granules had ferritin labeled plasma membranes. The density of ferritin on the plasma membranes decreased as the number of PO+ secondary lysosomes decreased with maturation. MØ from 96-120 hr cultures treated similarly had no ferritin label, were PO- and contained numerous secondary lysosomes. The antigens on ferritin labeled immature cells with PO+ granules, consistent with current classifications based on PO reactivity, were designated exudate macrophage surface antigens (EMSA). (Supported by MCV/VCU Grant-in-Aid).

PHENOTYPIC VARIATION AND OCULOCUTANEOUS INVOLVEMENT IN A RURAL VIRGINIA KINDRED WITH X-LINKED OCULAR ALBINISM. K.A.Szymanski*, J.A.Boughman*, R.S.Weinberg*, D.L.Olansky*, and W.E.Nance*. Dept. of Human Genetics, Med. Col. of Va., Richmond, Va.   23298

X-linked ocular albinism is a rare genetic eye disease characterized by impaired visual acuity, photophobia, nystagmus, and decreased retinal pigment. A large rural Virginia kindred previously diagnosed with congenital nystagmus is presented which includes 287 individuals with 31 males reported to be affected. Ophthalmologic exams were consistent with the Nettleship-Falls type of X-linked ocular albinism showing albinotic fundi, macular hypoplasia and decreased acuities in affected males, and variable fundus pigmentation but normal acuities in carrier females. Severity of nystagmus was variable among affected males and was correlated to the amount of retinal pigment. Linkage analysis did not show the expected linkage with the Xg blood group. Cutaneous involvement has previously been demonstrated by the presence of macromelanosomes in both affected males and carrier females. Since disease expression is so variable, use of skin biopsies may be a useful adjunct in diagnosis of at-risk females. To test this, skin biopsies on 6 individuals were interpreted without knowledge of the clinical phenotype. The cutaneous melanosome abnormality was demonstrable indicating that routine light microscopic confirmation of carrier status in females is feasible and can be useful for the evaluation and counseling of at-risk individuals in families with X-linked ocular albinism.

TWINNING IN VIRGINIA: WHY IS IT DECLINING? M. Mosteller*, J. I. Townsend, L. A. Corey*, and W. E. Nance*. Dept. of Human Genetics, Med. Col. of Va., Va. Commonwealth Univ., Richmond, VA 23298

Studies of secular trends in twinning rates show that the rates have been declining during this century in many nations around the world. More detailed analyses commonly reveal that the decline in overall rates is due to the dizygotic twinning rates; the monozygotic rates remain unchanged. In most nations the decline in dizygotic rates cannot be explained even after adjustment for maternal age and parity, known co-variables. Twinning rates for Virginia were calculated for comparison with the rates of other localities and investigation of possible causes for secular decline. Twinning rates declined by approximately 30% from 1918 to 1977 in Virginia. Twinning rates for selected years from 1938 to 1977 showed that, as elsewhere, dizygotic rates fell while monozygotic rates remained steady. Regression techniques showed that the decline was fully attributable to changes in maternal age and parity. Significant fluctuations in the annual twinning rates could not, however, be similarly explained. A fall in twinning rates at the beginning of the Depression and World War II suggested that emotional stress may play a role in secular changes in twinning rates. Emotional stress can lower the probability of physiological events essential to the formation of a dizygotic twin pair. Perhaps emotional stress has contributed to the decline in twinning rates around the world.

NICOTINE-INDUCED CHANGES IN BLOOD PRESSURE, HEART RATE RESPIRATION AND ANTINOCICEPTION AFTER INTRAVENTRICULAR INJECTION INTO RATS. H.L. Tripathi*, T.C. Fu*, M.D. Aceto* and B.R. Martin. Dept. of Pharmacology, Med. Col. of Va., Richmond, VA 23298.

The purpose of the present investigation was to determine whether or not nicotine produced antinociception after intracerebroventricular (I.C.V.) injections and whether or not antinociception was related to other nicotine effects. Nicotine (75 µg in 10 µl) was administered I.C.V. in male Sprague-Dawley rats (N=4) anesthesized with pentobarbital. Antinociception was measured by the tail-flick latency and blood pressure, heart rate and respiration were recorded at 0.5,1,2,5,10 and 20 mins. Nicotine caused maximum reduction in blood pressure (37%) and heart rate (17%) at 1 min. which returned to normal by 2 and 20 min., respectively. Respiration increased 22% at 0.5 min. but was normal by 2 min. Maximum antinociception (100%) was achieved at 2 min. and then declined gradually to 15% by 15 min. These results show that nicotine antinociception occurred independently of other nicotine effects. We also studied the distribution of ^3H-nicotine (75 µg, I.C.V.) in brain areas, plasma and spinal cord. In brain, higher concentration of nicotine were found in hypothalamus, hippocampus, striatum and midbrain than in cerebellum, medulla and cortex. Nicotine readily penetrated the blood-brain barrier and appeared in the periphery. It remains to be established whether nicotine antinociception is totally central. (Supported by DA-02384).

D- AND L-LACTATE CATABOLISM IN TISSUES. M.G. Waters*, M.J. Rispler*, E.S. Kline and R.B. Brandt. Dept. of Biochemistry, Medical College of Virginia, VCU, Richmond, Virginia 23298

Lactic acid metabolism is important physiologically for production of cellular energy, maintainance of blood glucose levels, storage of carbohydrates, and maintainance of acid-base balance. These functions have been associated with the L(+) enantiomorph of lactate from glycolysis. The "unnatural" isomer, D(-)-lactate, is formed in the catabolism of the 3-carbon growth inhibitor, methylglyoxal, by the glyoxalase enzymes and is found in measurable quantities in blood. In our study of the glyoxalase enzyme system, we became interested in determining the metabolic fate of D(-)-lactate. Specifically, we wanted to compare the rates of oxidative catabolism of D- and L-lactate in various mammalian tissues. Uniformly labeled (U-^{14}C) D- or L-lactate was incubated at 37° in a closed system with tissue homogenates in Krebs-Ringer phosphate buffer. Evolved $^{14}CO_2$ was trapped in a center well containing a fluted filter paper saturated with strong base and the radioactivity was determined. The rat tissues in which the D isomer is oxidized most rapidly are the heart, kidney, brain and liver. In liver and heart, the rate of oxidation of D-lactate exceeds that of L-lactate. The ratio of L-lactate to D-lactate oxidation is greatest in brain, followed by kidney, heart and liver. These results indicate that the rate of D-lactate catabolism is considerably greater than has been reported previously. (Supported by funds from the National Foundation for Cancer Research)

STIMULATION OF PROTEOGLYCAN SULFATION IN ISOLATED CHONDRO-SARCOMA CELLS BY INSULIN. D.H.Willis, Jr.* and J.P.Liberti* Dept. of Biochemistry, Med. Col. of VA., Richmond,VA 23298.

Mammalian cartilage responds to several growth promoting hormones. Owing to the difficulty of cartilage isolation and its tenacity, little more than descriptive information of these responses is available. Rat chondrosarcoma (CS) offers advantages over normal cartilage because larger amounts of tissue (>40 g) are readily obtained and easier to manipulate. Isolated cells were prepared from tumor minces by treatment with 0.2% collagenase at 37° for 20 min. Cells were washed, suspended in a modified culture medium and incubated ± test substances at 37°. After the appropriate labeling and incubation times, acid-precipitable radioactivity was measured. Continuous and pulse labeling experiments with $^{35}SO_4$ (1µCi/ml) demonstrated that a 6-8 h pulse gave optimal stimulation with both normal human serum (NHS) and insulin. Concentration curves from 0.6-5 X 10^5 cells/ml showed that maximal stimulation occurred from 1-2 X 10^5 cells/ml. Stimulation of proteoglycan sulfation by both insulin (0.7nM-181 nM) and NHS (0.5-15%) was concentration dependent. 36nM insulin gave maximal stimulation 31% above control (P<.01) while 16% stimulation was observed as low as 0.7-1.8 nM (P<.05). 5% NHS stimulated 47% above control (P<.01). These results represent the first demonstration that freshly isolated CS chondrocytes respond reproducibly to insulin. Experiments are planned to study the mechanism of action of insulin at the molecular level.

AGING AND THE INFLAMMATORY RESPONSE OF MICE TO
THIOGLYCOLLATE. J.R. Yannelli and A.K. Szakal, Department
of Anatomy, Medical College of Virginia, Richmond,
Virginia 23298.
    Experiments were designed to study the peritoneal cell
response of 6 wk., 33 wk., and 73 wk. old C57BL/6J female
mice to the inflammatory agent thioglycollate.
Thioglycollate was injected i.p. (1 %/5 gm body weight).
The PE cells were harvested by lavage with cold DMEM at
24 hr. intervals for 7 days. The cells were counted and
characterized by nuclear morphology, peroxidase and
nonspecific esterase reactivity. The resident population
of cells in the age groups studied were composed of
predominantly lymphocytes and a lesser number of
macrophages (20.5 $\pm$ 2% in 6 wk., and 13 $\pm$ 2% in 73 wk old
animals). After the i.p. injection of thioglycollate
there was an influx of peroxidase positive neutrophils
and monocytes in addition to lymphocytes into the
peritoneal cavity. The influx of peroxidase positive
cells appeared to cease between 48 and 72 hours. The
cellular composition of the peritoneal exudates changed
with age. There was an increase in total cell number,
however the fraction of peroxidase positive and
nonspecific esterase positive cells decreased with age.
This decrease is interpreted as a possible cause in the
age-related decline in immunocompetence and wound healing.

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HETEROCYST PIGMENTATION IN THE SYMBIOTIC CYANOBACTERIUM ANABAENA AZOLLAE. N. Azrolan*, R. Fisher*, and J. Gates. Dept. of Biology, Va. Comm. Univ., Richmond, VA 23284.
    The Azolla-Anabaena azollae association is the subject of much interest because it is an efficient nitrogen-fixing system. The site of nitrogen-fixation is localized in specialized cells of the cyanobacteria called heterocysts.
    Mature heterocysts of free-living Anabaena do not fluoresce under the fluorescent microscope; whereas, mature heterocysts of the cyanobacteria micromanipulated from the fern leaf cavity do fluoresce. The quality and level of this fluorescence is dependent upon the age of the leaf from which the algal samples are taken. Heterocysts were isolated by the methods of Peterson (Plant Physiol. 61:688, 1978) and were subsequently extracted by freeze-thaw methods. Spectrofluorometric analysis of the cell-free extracts of these heterocysts demonstrate that phycocyanin (PC) is present. PC normally exists as an accessory pigment to PSII. Since there is no PSII activity in the heterocysts of Anabaena, the PC may be involved in transferring energy to PSI in heterocysts of the symbiotic cyanobacteria. Supported by USDA 5901-0410-9-0304-0.

RESPONSIVENESS OF T LYMPHOCYTE SUBSETS TO MACROPHAGE-DERIVED FACTORS. S.P. Black, K.D. Elgert, and J.M. Conroy. Dept. of Biology, Microbiol. Sect., Va. Polytechnic Inst. and State Univ., Blacksburg, VA. 24061
    The mixed lymphocyte reaction (MLR) was used to examine the response of normal and tumor-bearing host (TBH) murine T lymphocyte subpopulations in the presence of normal and TBH macrophage (MØ) factors. Rapidly proliferating normal Lyt 1^+ cells were enhanced beyond the level of unfractionated T cells by both normal and TBH MØ supernatants. TBH Lyt 1^+ cells were enhanced by normal MØ supernatants but TBH MØ supernatants inhibited the response. Slowly proliferating normal Lyt 2^+ cells were restored to control levels by normal MØ supernatants but TBH MØ supernatants failed to restore the response. TBH Lyt 2^+ cells were inhibited by normal MØ supernatants, and although the inhibition by TBH MØ supernatants was titratable, higher dilutions did not restore the response. Thus, TBH MØ supernatants are altered from normal MØ supernatants and TBH Lyt 2^+ cells are altered in their ability to be augmented by MØ-derived factors. These data shed some light on the mechanisms of tumor-induced immune debilitation. (Aided by a Whitehall Foundation Grant, by NIH Grant CA 25943, and by a Sigma Xi Scientific Research Society Grant-in-Aid of Research.)

DIFFERENCES IN SURFACE ANTIGENICITY OF THE N-FIXING PHYCOBIONTS OF DIFFERENT SPECIES OF THE AZOLLA FERN. D. Brown*, J. Gates, and R. Fisher*. Dept. of Biology, Va. Comm. Univ., Richmond, VA 23284.
    The cyanobacteria in the Azolla fern are named Anabaena azollae; however, little evidence supports the hypothesis that all species of Azolla associate with the same phycobiont. Antisera were prepared against cyanobacteria freshly extracted from the leaf cavities of Azolla pinnata, A. caroliniana, and A. microphylla and used in adsorption and cross-reaction studies using fluorescent antibody staining. Initially all 3 phycobionts reacted strongly with all 3 antisera, and only after extensive adsorption could differences be detected. A. pinnata phycobiont appears to have antigens not present on the surfaces of the other 2 species. The phycobionts from A. caroliniana and A. microphylla appear to have antigens not present on the A. pinnata phycobiont. Since A. pinnata is in the Subgenus Rhizosperma and the others are in the Subgenus Euazolla, these slight differences in surface antigenicity follow the phylogeny of the fern. Supported by USDA 5901-0410-9-0304-0.

CHARACTERIZATION OF THE BOVINE PARVOVIRUS GENOME. P. R. Burd, R. C. Bates, and E. R. Stout. Dept. of Biology, Va. Polytech. Inst. and State Univ., Blacksburg, VA. 24061.
    A restriction map was prepared for the bovine parvovirus (BPV). Isolated single-stranded viral DNA was radio-labeled by incorporation of $[\alpha-{}^{32}P]$-dNTP's using bacterial and viral DNA polymerases at positions representing the 3' or 5' termini of the viral DNA or at positions internal to the termini. Specifically radiolabeled viral DNAs were digested with various restriction enzymes and separated by agarose or polyacrylamide gel electrophoresis. Sizes of viral DNA fragments were determined by comparison to separated restriction fragments of M13 RF DNA. The fragment order was determined by incomplete digestion of specifically labeled viral DNAs. The order of fragments was determined for nine enzymes (Bamh I, Bgl I, Bgl II, BstE II, EcoR I, Hinc II, Hpa I, Kpn I and Pst I). For these enzymes most of the cleavage sites were located near the ends. No sites were found for Hind III, Sal I, Sma I, Sst II and Xor II. Comparison of the BPV restriction map to maps of rodent parvoviruses (MVM, H-1, KRV) and other parvoviruses shows that BPV possesses a restriction map distinct from the rodent parvoviruses.

INTERLEUKIN 2 DEFICIENCY AND IMMUNE PARALYSIS IN TUMOR-BEARING HOSTS. C.J. Burger, K.D. Elgert, and W.L. Farrar*. Dept. of Biology, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061 and Frederick Cancer Res. Ctr., Frederick, MD 21701

Normal and tumor-bearing host (TBH) BALB/c mouse whole spleen cells were cultured for 24 hr in the presence of concanavalin A and their supernatants tested for the level of Interleukin 2 (IL 2) and Interleukin 3 (IL 3) activity. IL 2 and IL 3 are soluble T cell lymphokines. A 28 day kinetic study, using a methylcholanthrene-induced transplantable fibrosarcoma, revealed that IL 2 levels dropped 59% between Days 8 and 10 of tumor burden and no IL 2 was detectable at Day 28. IL 3 activity also dropped 59% but between Days 4 and 8. Only 12% of normal baseline IL 3 activity was present at Day 28. Normal and TBH spleen cells were separated by nylon-wool into an adherent cell fraction, enriched for B cells, macrophages (MØ), and suppressor T cells, and nonadherent cell fraction enriched for T helper cells. The respective fractions were assessed for lymphokine activity. The adherent population was more suppressive of IL 2 and IL 3 activity than its nonadherent counterpart. An initial in vitro comparison of normal and TBH spleen cell reactivity to lymphokines was performed. A sequential cascade model for amplification of cellular immunity by lymphokines was presented showing the putative effects of IL 1, IL 2, IL 3, and immune interferon. (Aided, in part, by a VAS Grant and a Whitehall Foundation Grant.)

DIBEKACIN: AN IN VITRO COMPARISON WITH GENTAMICIN. F.L. Chan,* H.P. Yu* and S. Shadomy. Depts. of Medicine and Pathology, Med. Col. of Va. VCU, Richmond, VA 23298.

The antimicrobial activity of dibekacin (DKB), an aminoglycoside antibiotic derived from kanamycin B, was assessed in vitro by both the standardized agar dilution (WHO-ICS) and diffusion disc (FDA) tests. DKB was equal in activity to gentamicin (GM) when tested against isolates of Escherichia coli, Staphylococcus aureus, and Enterobacter aerogenes. It was significantly more active than GM when tested against Pseudomonas but significant less active than GM when tested against Serratia spp. Diffusion disc studies demonstrated the feasibility of using a 10-µg disc in routine testing with DKB; tentative "breakpoints" for such tests were recommended. These followed the pattern recently established by NCCLS for use with gentamicin and tobramycin diffusion disc tests ("resistant", zone dia. <12 mm; "intermediate", zone dia. of 13 or 14 mm; "susceptible", zone dia. >15 mm). The reliability of the DKB 10-µg disc is now being evaluated.

PRELIMINARY STUDIES OF THE ACTIVITIES OF LACTOSE FERMENTING BACTERIA IN AN ESTUARINE ENVIRONMENT. S. Cioccia and C. W. Erkenbrecher, Old Dominion University, Norfolk, VA 23508

This study was initiated to document the heterotrophic activity of bacterial populations in the polluted Lynnhaven estuary. The activity of the total viable bacterial population was measured using ^{14}C-Glucose and the fecal coliform population activity was estimated from measurements of ^{14}C-Lactose uptake at elevated temperatures. Activities at the in situ temperature of 7 $^{\circ}C$ were compared for both substrates to incubation at 44.5$^{\circ}C$. Standard plots of the data (t/f versus A) illustrated typical Michaelis-Menten first order kinetics for both substrates tested. V_{max} values, indicative of an overall estimate of heterotrophic activity, were lower at the elevated temperature of 44.5$^{\circ}C$ than at in situ temperature. V_{max} values for glucose were 0.449 and 0.165 ug/l/hr for 7$^{\circ}C$ and 44.5$^{\circ}C$, respectively. Corresponding lactose V_{max} values were 2.584 and 0.153 ug/l/hr for the two temperatures. These studies have shown that fecal coliforms are potentially active in this estuarine environemnt. Continuing studies are focusing on a closer examination of the relationship between densities of indicator and pathogenic bacteria and their potential activity from heterotrophic uptake of radio-labelled substrates.

KETOCONAZOLE: SERUM LEVELS AS DETERMINED BY BIOASSAY AND BY HPLC. A. Espinel-Ingroff*, S. Shadomy, W.E. Dismukes* and the Cryptococcal Meningitis Chemotherapy Study Group. Dept. of Medicine, Med. Col. of Va., VCU, Richmond, VA. 23298.

Ketoconazole (KTZ) is an orally active imidazole under study for use in treatment of a variety of fungal infections including those caused by both systemic and opportunistic pathogens. The recommended dose is 200 mg/day; this is to be taken with meals. Sera from over 20 patients being treated with KTZ were assayed by both bioassay and HPLC. Excellent correlation was demonstrated when the two sets of data were analyzed ($r_{(125)}$ = 0.8224). Two hour assay values in patients receiving the recommended dose ranged from "trace" amounts to values in excess of 4.0 µg/ml. Values as high as 9 µg/ml were measured in patients receiving 600 mg/day. However, some patients receiving this same dose had serum levels of less than 2.0 µg/ml. These data suggest considerable variability in the gastrointestinal uptake of KTZ. Additional studies revealed poor penetration of KTZ into either cerebrospinal or synovial fluids. These latter data suggest certain limitations in the clinical usefulness of KTZ (WED and the CMCSG supported by NIH-NIAID contract NO1 AI82570).

MOLECULAR ORGANIZATION OF THE STREPTOCOCCAL R PLASMID pIP501. R.P. Evans, Jr. and F.L. Macrina. Department of Microbiology, Virginia Commonwealth University, Richmond.

The organization of the self-transmissible resistance plasmid, pIP501 (20 Mdal), capable of transfer among numerous streptococcal species, was determined by molecular cloning of restriction endonuclease fragments using a cryptic plasmid vector, pVA380-1 (2.8 Mdal). pIP501 encodes resistance to chloramphenicol (Cm^r) and erythromycin (Em^r, macrolide-lincosamide) antibiotics. Restriction endonuclease digested fragments of vector and pIP501 DNA were ligated in vitro and introduced into competent Streptococcus sanguis (Challis) by transformation. Cm^r transformants contained a 5.3 Mdal recombinant plasmid which resulted from the ligation of a 4.2 Mdal Hind III fragment of pIP501 with the Hind III digested vector. Em^r transformants contained a 4.0 Mdal recombinant plasmid, pVA794, which resulted from the ligation of a 1.4 Mdal Hind -Ava I fragment of pIP501 with Hind III-Ava I digested vector. The Hind III fragments bearing the Em^r and Cm^r determinants were found to be contiguous on pIP501. Hind III cleaved, self-ligated pIP501 DNA yielded only Cm^r transformants in S. sanguis. Such transformants contained a recombinant plasmid (pVA798, 5.3 Mdal) consisting of the 4.2 Mdal Hind III fragment and a contiguous 1.1 Mdal Hind III fragment. Our data suggest that the regions involved in antibiotic resistance and plasmid replication are clustered on the conjugative streptococcal R plasmid pIP501.

CRYPTOCOCCUS NEOFORMANS: SEROTYPING OF CLINICAL ISOLATES FROM A MULTICENTER CHEMOTHERAPEUTIC TRIAL. R.A. Frontling*, S. Shadomy, H.J. Shadomy, W.E. Dismukes*, and the Cryptococcal Meningitis Chemotherapy Study Group. Depts. of Microbiology and Medicine, Medical College of Virginia, VCU, Richmond, VA 23298

Antigenic heterogeneity in Cryptococcus neoformans is well known and four serotypes (A,B,C,D) have been recognized. Serotypes A and D are associated with C. neoformans var. neoformans and serotypes B and C with C. neoformans var. gatti. Historically, BC serotypes have been limited to clinical isolates from southern California and S.E. Asia. Ninety clinical isolates from 13 states were tested for serotype by culturing on creatinine-dextrose-bromthymol blue agar. With this medium, organisms can be divided into serotype groups AD or BC based on their ability to rapidly assimilate creatinine. Twelve (13%) of the 90 isolates were serotype BC. There was a wide distribution of BC serotypes throughout the country; one strain from California, one each from Alabama and Louisiana, 2 each from Missouri, North Carolina and Virginia, and 3 from Tennessee. These data suggest that BC serotypes, previously thought to be strictly limited in their geographic occurrence, may have a greater distribution than originally hypothesized. The epidemiologic significance of this observed BC distribution, as well as the success of chemotherapy in AD versus BC infections are being investigated. (RAF supported by Inst. NRS Award AI-07086 from NIAID).

HETEROGENEITY IN ANTITUMOR FUNCTION AND ECTOENZYMES IN MOUSE PERITONEAL MACROPHAGES (MØ). E.J. Jessee *, M.A. Rozner *, and P.S. Morahan. Virginia Commonwealth Univ., Richmond, VA.

To define MØ lineage and development, we separated peritoneal cells into four size groups using discontinuous Ficoll and rate zonal centrifugation. After MØ purification by adherence for 2 hr, each unseparated and size group was assayed for antitumor and ectoenzyme specific activities (SA). MØ were obtained from untreated (RES), C. parvum pretreated (CP), and thioglycollate broth pretreated (TG) ♀ BALB/c mice. All groups were subjected to differential and size analysis.

Only CP MØ exhibited antitumor activity; this activity was found in the unseparated and largest size CP groups. Alkaline phosphodiesterase (APD), 5'-nucleotidase (5'N), and leucine aminopeptidase (LAP) ectoenzyme SA were measured. Both unseparated CP and TG MØ showed ectoenzyme profiles different from RES MØ. In the size groups, the larger MØ had SA similar to the respective unseparated MØ. All of the small MØ size groups (RES, CP, TG) had lower 5'N than, and similar APD to, the SA of the unseparated RES MØ.

MØ	APD	5'N	LAP
Unsep. and large CP	Decreased	Decreased	Increased
Unsep. and large TG	Same	Decreased	Increased
Small RES, CP, TG	Same	Decreased	Insuff. data

The LAP SA are now being measured for the small MØ. This catalogue of functions and characteristics emphasize the heterogeneity in the MØ cell series and will help elucidate the process of MØ differentiation. (Supported by CA 24686).

IMMUNOCHEMICAL RELATIONSHIPS AMONG PLANT PEROXIDASES. Les-A. McDonell* and James M. Conroy. Dept. of Biology, Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061.

Rabbit antibodies specific for the basic isoenzyme of horseradish peroxidase (HRP) were used to probe the relationships between HRP isoenzymes and peroxidases from other plants. Cross reactivity of antibody specific for the basic isoenzyme of HRP with two acidic HRP isoenzymes was demonstrated by immunodiffusion. The degree of cross reactivity was quantitated as 36% by precipitin tests. However, the antibody did not inhibit the catalytic activity of the acidic isoenzymes (Maximum inhibition of the basic isoenzyme was 80%).

Basic peroxidase isoenzymes from carrot, turnip, and radish were purified and tested for reactivity with antibody specific for the basic HRP isoenzyme. Cross reactions with all plant peroxidases were shown by immunodiffusion. In all cases, the degree of cross reaction with carrot (41%), turnip (49%) or radish (77%) was greater than that observed with the acidic HRP isoenzymes. Antibody did not inhibit the catalytic activity of the turnip or carrot enzymes. However the radish enzyme was inhibited significantly (60%).

The results indicate that the basic isoenzymes of turnip, carrot, and radish are more closely related to the basic HRP isoenzyme than the acidic HRP isoenzymes.

TRANSMISSIBLE CLINDAMYCIN RESISTANCE IN BACTEROIDES OVATUS. C.J. Smith*, and F.L. Macrina. Dept. of Microbiology, Virginia Commonwealth University, Richmond, VA 23298

A clinical isolate of Bacteroides ovatus resistant to the lincosamide-macrolide (LM) antibiotics clindamycin, lincomycin, and erythromycin, and to tetracycline, was found to transfer the LM-resistance to suitably marked B. uniformis strains when the cells were co-cultured on nitrocellulose filters. The transfer of resistance occurred at frequencies of 5×10^{-6} to 1.5×10^{-5} drug resistant progeny per input donor cell. In no case was the transfer of tetracycline resistance observed. The transfer event was mediated by a conjugation-like process which was insensitive to deoxyribonuclease and required cell to cell contact. Drug resistant progeny isolated from the primary crosses were able to transfer the LM-resistance markers to suitable recipient strains of B. fragilis and B. ovatus. Transfer of the LM-resistance phenotype was always accompanied by the transfer of a 27 $\times 10^6$-dalton plasmid (designated pBF6). Restriction endonuclease digestion patterns of pBF6 showed several fragments in common with the previously characterized LM-resistance plasmid pBF4 (originally isolated in B. fragilis). Our data suggest that pBF4 and pBF6 share a common ancestry despite their occurrence in different species of the genus Bacteroides.

AN ELISA PROCEDURE FOR ANATID HERPESVIRUS. Margaret Lewis and J. C. Johnson. Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23508.

Duck plague is a hemorrhagic disease affecting the family Anatidae, resulting in 60-80% mortality in captive flocks. Plaque and neutralization assays for Anatid herpesvirus (AHV) require 5-10 days for completion and are restricted by the seasonal availability of fertile duck eggs. The enzyme-linked immunosorbent assay (ELISA) is rapid and specific and avoids the use of living cells. The Holland strain of AHV (ATCC VR #684) was grown on duck embryo fibroblasts and purified by banding on CsCl. The resulting virus was used to raise antisera in prebled New Zealand white male rabbits. Antibody production was confirmed in double diffusion plates and by neutralization. The IgG component of the AHV-specific antiserum was prepared by ammonium sulfate precipitation. The standard directi:ELISA of 0.25 ml used AHV-specific IgG coupled to horseradish peroxidase and azino di-(3-ethylbenzthiazoline sulfonate) as the enzyme substrate. Reaction parameters, including time, pH, antigen and conjugated-antibody concentration, solid phase, as well as interference by host cells, were varied for optimization of the assay. The assay appears to be sensitive to as little as 32 ng of protein. With the preparation of a highly purified virus and antiserum with high specificity, the ELISA system may become a basic procedure for AHV identification.

ANALYSIS OF BPV DNA SYNTHESIS IN VITRO. A. T. Robertson, E. R. Stout, R. C. Bates. Dept. of Biol., Va. Polytechnic Inst. and St. Univ., Blacksburg, VA 24061.

An in vitro reaction system has been used to study the replicative intermediates which occur during bovine parvovirus (BPV) DNA synthesis. The system is composed of nuclei isolated from BPV-infected bovine fetal lung cells and lysed with EDTA and MgCl2. This nuclear lysate contains the viral DNA templates, preformed in vivo, and enzymes necessary to continue DNA synthesis in vitro in the presence of ^{32}P-deoxyribonucleotides. In this study, the DNA products were separated by rate zonal centrifugation in 5-20% sucrose gradients with 4 M guanidine-HCl. Fractions containing viral DNA were electrophoresed on 1.4% agarose gels and the position of the radioactive DNA was detected by autoradiography. Hence, only molecules labeled in vitro were visualized. Bands corresponding to all previously identified viral replicative intermediates were observed. The molecules which migrated to the position of dimer DNA in the gradient consisted of low levels of unit length single stranded BPV DNA, double stranded replicative forms and dimer DNA. This entire dimer DNA fraction from the gradient, was replicated with E. coli DNA polymerase 1 (Klenow fragment) and digested with restriction enzymes. The DNA fragments produced were found to be identical to single stranded virion DNA replicated and cut in the same manner.

THE ENUMERATION OF PETROLEUM-DEGRADING BACTERIA FROM THE ELIZABETH RIVER ON A SILICA-GEL OIL MEDIUM. S. W. Sokolowski and C. W. Erkenbrecher. Old Dominion Univ., Norfolk, VA 23508.

A silica gel-petroleum (SGP) medium was developed to enumerate petroleum-degrading bacteria in estuarine environments. This medium is extremely versatile. The salinity of the medium can be varied from 0 to 35 ppt, pH drift is negligible ($\pm$ 0.2 pH units after 166 days) and a wide variety of liquid hydrocarbons such as kerosene, motor oils, crude oils and Bunker C (#6) fuel oil can be incorporated easily into the medium without sonication. Furthermore, extraneous carbon contamination and water loss due to syneresis are significantly reduced. The shelf-life of the medium at room temperature (up to 5 months) is limited only by the chemical stability of the petroleum if a humid atmosphere is properly maintained.

A field study was undertaken to test the SGP media and to gather preliminary data on the general water quality of the Elizabeth River. The mean densities of petroleumolytic bacteria in Elizabeth River surface waters were 17, 12 and 11 CFU per 100 ml, as enumerated on Bunker C, South Lousiana Crude Oil and 20 weight motor oil SGP media, respectively. These enumerations are two to three orders of magnitude lower than those of the corresponding MPN medium which was used for comparative purposes. It is hypothesized that the difference in estimates of petroleumolytic bacteria in the Elizabeth River is due to a concentration of bacteriocidal pollutants on the SGP membrane filter whereas these pollutants are diluted in the MPN media.

MARKER RESCUE IN STREPTOCOCCUS SANGUIS - IMPLICATIONS FOR SHOTGUN CLONING. J. Ash Tobian*, and F.L. Macrina. Dept. of Microbiology, Virginia Commonwealth University, Richmond, Virginia 23298

The covalently closed circular form of pVA736, a 5.0 x 10^6 dalton chimeric plasmid conferring erythromycin resistance, genetically transformed Streptococcus sanguis with high efficiency (>10^{-3} transformants per recipient). This efficiency was constant in isogenic recipients which 1) were plasmidless, 2) contained a plasmid that shared homology with pVA736, or 3) contained a plasmid that shared no homology with pVA736. When linearized by restriction endonuclease cleavage, pVA736 was unable to efficiently transform either the strain lacking a plasmid or the strain containing the nonhomologous plasmid (<10^{-5} transformants per recipient). However, linearized pVA736 could efficiently transform the strain containing the homologous plasmid, yielding >10^{-3} transformants per recipient, by a process termed "marker rescue." In Streptococcus sanguis multimeric plasmid forms are known to transform by a first order process while monomers transform by a second order process. Because the generation of multimers or a significant number of like monomers during "shot gun" cloning of chromosomal fragments is unlikely, a "helper cloning" method based on the "marker rescue" model can be utilized to preclude this problem.

MICROBIAL FLAGELLA STAINING: METHOD OR MAGIC
T.L. Weaver. Dept. of Biology, Liberty Baptist College, Lynchburg, Va. 24506

The techniques for staining of microbial flagella have been accompanied through the years by an aura of uncertainty due to the highly variable results one obtains while seemingly following standard proven procedures. The most predictable and widely used procedure today is the method developed and modified by Leifson(1951). This stain which includes sodium chloride, tannic acid, basic fuchsin, ethanol, and water is recommended in most standard methods manuals which include techniques for staining microbial flagella. Although the stain composition seems relatively uncomplicated, this study has revealed that much of the variability in results can be traced to variability in the basic fuchsin component. A variety of salts of pararosaniline, rosaniline, magenta II, and new fuchsin may all be considered "basic fuchsin." While any of these can yield a successful stain, the factor that must be carefully adjusted with the various different basic fuchsins is pH since the final pH can vary quite a bit depending upon the particular dye used. Adjustment of pH to 5 removes most of the magic from flagella staining via Leifson's method. Slide preparation, culture, timing, and storage of the stain are important secondary factors influencing the success of the operation.

PROTEIN CHANGES DURING ENFLAGELLATION OF NAEGLERIA FOWLERI. T.W. Woodworth, W.E. Keefe, and S.G. Bradley. Virginia Commonwealth University, Richmond 23298.

Amebae of Naegleria fowleri nN68 become enflagellated within 4 h after transfer to non-nutrient buffer. Enflagellation requires de novo protein synthesis, necessitating regulation of protein levels to provide precursors. Protein changes during enflagellation have been studied using radiolabeled proteins resolved by two-dimensional electrophoresis. Densitometric scanning of autoradiograms was combined with computer-assisted analyses to determine whether general correlations exist between amounts or numbers of polypeptides and their size or charge. Some correlations were observed between mean amounts of polypeptides and their size or charge; these prevail in flagellates as well as in amebae. Specific comparisons of the ca. 500 resolved polypeptides present in amebae and flagellates reveal only 20 to 30 species which either appear, disappear, or markedly change in amount during enflagellation. Few of the changes were specific to the enflagellation process when compared to the changes observed in an identically treated non-enflagellating strain. A small number (ca. 50) of resolved polypeptide species are phosphorylated in growing amebae. Shifts in the number and patterns of polypeptide phosphorylation during enflagellation are under investigation. Studies of protein regulation during N. fowleri enflagellation should provide insights into regulatory mechanisms in eukaryotic cells.

THE ECOLOGICAL CONDITION OF BACTERIAL COMMUNITIES IN A LAKE WHICH RECEIVES ACID MINE-POLLUTION. R.A. Wassel*, and A.L. Mills*. Dept. of Environmental Sciences, Univ. of Va. Charlottesville, Va. 22903

Bacteria in various locations of Lake Anna, a freshwater reservoir in central Virginia which receives acid mine-water, were compared as to community attributes over a one year period. The total cell-densities in an area of the lake closest to an inflow stream carrying mine effluents were not significantly different from either a downstream portion or a section unexposed to acid pollution. However, the number of viable heterotrophs increased with the distance from the pollution source. When tested under cultural conditions, the diversity of bacteria isolated from the several sites did not markedly differ, nor did the microbes' abilities to perform various ecological functions. Heterotrophic activity however, (uptake of ^{14}C-labeled glucose) was less at the most polluted site than the other two areas. These findings suggest that the presence of acid mine-pollution is associated with a decrease in the reaction rates of heterotrophic processes, and that this effect is relieved as the mine drainage is diluted by the large volume of water in Lake Anna. These findings also imply the validity of the theory that ecological properties of biotic communities tend to diminish in magnitude in the presence of pollution which is toxic to some, but not all members of that community.

MICONAZOLE: IN VITRO TEST VARIABLES. S.C. White*, H.P. Yu*, A. Espinel-Ingroff and S. Shadomy. Dept. of Med., Med. Col. of Va., VCU, Richmond, VA. 23298

In vitro susceptibility tests with imidazoles such as miconazole (MCZ) and ketoconazole require standardization if they are to be used in the routine clinical laboratory. A series of experiments were conducted in order to identify those variables which would affect the results of such tests with pathogenic yeasts and MCZ. Three test procedures were used: agar dilution, broth dilution and Microtiter. Three media were evaluated: Sabouraud's (SAB), FDA-M3 (M-3), and casein-yeast extract-glucose (CYG). Three inoculum sizes were tested: 10^2, 10^4 and 10^6 CFU. Results were evaluated after 48 hr and 5 days incubation. The most significant variable involved the presence or absence of agar in the test media. The presence of agar raised broth dilution MIC values by at least a 4-fold factor in a number of tests with isolates of Candida. Variations in inoculum size was an important variable in broth but not in agar dilution tests. Increasing the incubation period was a minor source of discrepant data. The results of these studies show that considerable effort will be required to provide a routine clinically reliable test procedure for miconazole and related antifungal compounds.

KETOCONAZOLE: SUSCEPTIBILITY TESTING OF CLINICAL ISOLATES OF PATHOGENIC FUNGI. H.P. Yu*, S.C. White*, S. Shadomy, W. E. Dismukes*, and the Cryptococcal Meningitis Chemotherapy Study Group. Dept. of Medicine, Med. Col. of Va., VCU, Richmond, VA. 23298

Ketoconazole (KTZ) was tested in vitro against sixty four isolates of systemic and opportunistic fungal pathogens by broth dilution using 3 different media. KTZ was most active when tested in nonsynthetic media such as FDA M-3 broth (M-3) and least active when tested in a synthetic medium such as casein-yeast extract-glucose broth. Isolates of dimorphic systemic pathogens were highly susceptible to KTZ. The MIC_{90} values of KTZ in M-3 for Blastomyces dermatitidis, Histoplasma capsulatum and Coccidioides immitis were 0.39 μg/ml or less. Isolates of Cryptococcus neoformans and Sporothrix schenckii were less susceptible. Only 3 of 8 isolates of the former were susceptible to 3.13 μg/ml of KTZ; 0.39 μg/ml of KTZ was inhibitory for 5 of 7 isolates of the latter. A number of isolates of C. immitis were repeat isolates from patients being treated with KTZ; emergence of clinical resistance was not observed among these isolates. Definition of the in vitro limits of clinical susceptibility or resistance have not yet been defined for KTZ. However, data obtained in this study suggest that a MIC of 1.56 μg/ml represents the upper limit of probable clinical susceptibility. (WED and the CMCSG supported by NIH-NIAID contract NO1 AI82570).

Psychology

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THE EFFECTS OF INFUSION OF PCPA WITH BOTH OSMOTIC MINIPUMPS AND IP INJECTION ON ACTIVITY, EATING, AND DRINKING. C.T. Albanese.* Dept. of Psychology, Washington and Lee University, Lexington, VA 24450 (Sponsor: L. E. Jarrard)

The production of serotonin in the rat brain was inhibited by administration of p-chlorophenylalanine (PCPA). The experiment consisted of two separate techniques of administration: 1) using intraperitoneally placed osmotic minipumps (Alzet Corp.), and 2) a single IP injection. Data collected from 5 male albino rats of the Wistar strain (200-225g) formed the basis for the experiment. Using a computer system, activity, eating, and drinking were monitored over each 24 hour cycle. Of the two techniques used, the results from the minipumps proved less significant than those of the IP injection. With both techniques, however, results indicated an increase in activity, and a decrease in both food and water consumption. However, in both cases, normal activity, eating, and drinking returned after 3 days of PCPA administration.

BEHAVIORAL AND NEURONAL EFFECTS OF PRENATALLY ADMINISTERED VALIUM IN THE RAT. Edward G. Brooks,* Department of Psychology, Washington and Lee Univ., Lexington, VA 24450; H. D. Graham,* LSU at New Orleans; Robert M. Eisdorfer,* Univ. of Tel Aviv. (Sponsor: L. E. Jarrard)

Previous research indicates that Valium injections administered to pregnant rats in the third trimester of pregnancy has a detrimental effect both on hippocampal neurogenesis and behavior (righting response, and spontaneous alternation). The purpose of the present experiment was to see if prenatal exposure to Valium affects more complex spatial behavior in adult animals.

Four pregnant females were given daily injections of Valium (10mg/kg) from days 13 to 20 of gestation. Three females served as controls. At the time of birth rat pups were divided into the following 4 groups: VV – 6 Valium exposed pups with Valium injected mothers, CV – 3 control pups with Valium injected mothers, CC – 3 control pups with control mothers, and VC – 6 Valium pups with control mothers. Training on an 8-arm spatial maze with all arms baited began on postnatal day 71 and this was followed with training where only 4 arms were baited. Results indicated significant behavioral differences between rats raised by Valium mothers as compared to control mothers. Prenatal Valium exposure had no significant effect. These results suggest that the experiences in the postnatal period may be more important than the prenatal exposure to Valium.

THE ROLE OF AFFECT IN THE SPACING EFFECT. David G. Elmes and N. J. Herdelin* Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450

The spacing effect refers to the superiority of recall after spaced or distributed practice. The difficult study-phase retrieval under spaced practice may be arousing, while massed practice may engender negative affect. This, plus the fact that spaced items are judged to be more familiar and occur more frequently than massed events, suggests that affect may play an important role in the spacing effect. In the present studies, subjects heard neutral, "good", or "bad" words under conditions of massed and spaced practice. Massing the practice of neutral words resulted in them being judged negatively, while spaced practice of the same words led to positive affective judgments. A substantial spacing effect in free recall was found only for the neutral words. In fact, the spacing effect was reversed for the "good" words. Positive and negative affect can determine the effectiveness of practice conditions, and the changes in affect associated with massed and distributed practice may account for their influence on recall. The present results are congruent with Zajonc's hypothesis that affect plays a crucial role in the information processing underlying most cognitive tasks.

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THE DOUBLE STANDARD OF DRINKING. B. Gillen* and C. Senft.* Department of Psychology, Old Dominion Univ., Norfolk, Va. 23508

The masculine and feminine sex roles are clearly defined in our society. Males are perceived as possessing traits which exemplify competence while females are expected to possess traits which denote warmth and expressiveness (Broverman, Vogel, Broverman, Clarkson, and Rosenkrantz, 1972). Further, it has been shown (Seyfried and Hendrick, 1973) that when people act out of role, masculine females, or feminine males, they are derogated. Such research implies that when females participate in the mascline behavior of heavy drinking that they will be evaluated more negatively than males that consume an equal amount. The following experiment tests these hypotheses.

Subjects read a transcript of a discussion between a psychologist and a male or female college student. During this conversation it was revealed that the student drank moderately or heavily. Subjects then described the students using the Bem Sex Role Inventory (Bem, 1974) and rated the student on a number of Likert-type items. The results confirmed the experimental hypotheses. Female heavy drinkers were seen as more likely to possess sex irrelevant bad traits. In addition, these females were expected to possess the negative characteristics associated with masculinity such as uses harsh language. Finally females who drink heavily received a less hopeful prognosis for recovery.

THE EFFECT OF INTROVENTRICULAR INFUSION OF PHYSOSTIGMINE ON COMPLEX SPATIAL LEARNING IN THE RAT. David J. Hepler,* Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450 (Sponsor: L. E. Jarrard).

Physostigmine has been recently shown to facilitate learning in rats. Because of the peripheral effects generated by this drug when administered intraperitoneally, only simple forms of learning such as passive avoidance have been investigated. It was felt that these deleterious effects could be bypassed by delivering physostigmine to the brain by direct intraventricular infusion. In the present study, the effect of physostigmine on activity and complex spatial learning was investigated. One week prior to the administration of the drug, experimental and control groups were taught to run a 12-arm radial maze in which only 6 arms were baited. The experimental group then received a unilateral $1 \mu g/\mu l$/hour continuous infusion of physostigmine from an osmotic minipump into the lateral ventricle over a 7 day period. Results indicated no significant difference between experimental and control groups for either activity levels or errors incurred in learning the spatial task. These results do not support those found by previous investigators who used intraperitoneal injections as the method of drug delivery. Implications of this study will be discussed.

SELECTIVE HIPPOCAMPAL LESIONS AND BEHAVIOR. Leonard E. Jarrard. Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450

The hypothesis that neuroanatomically discrete areas within hippocampus are differentially involved in behavior was studied in rats, using selective lesions involving either the fimbria, CA1 cells, and/or posterior alveus. Damage to the fimbria with the resulting interruption of rostral connections with subcortical structures is similar to extensive hippocampal lesions in causing increases in behavioral arousal and increased susceptibility to interference. Damage to CA1 cells and/or posterior alveal lesions that interrupt caudal hippocampal projections toward cortical areas have relatively little effect on behavior but do result in impaired acquisition of complex spatial tasks. Since damage to fimbria and alveus interrupts fibers of passage, thus complicating interpretation of the results, the use of chemical lesioning techniques with more discrete damage to hippocampal subdivisions should prove of value in future research.

THE SOCIAL SKILLS OF ADULTS WITH AUDITORY/VISUAL PROCESSING DEFICITS. P. A. Jarvis*, and E. M. Justice*. Dept. of Psychology, Old Dominion Univ., Norfolk, VA 23508

The social skills and self-concept of college students with varying degrees of auditory/visual processing deficits were examined. Such deficits have been termed learning disabilities in children and have been associated with significant academic and social difficulties.

Based on performance on a test of auditory/visual abilities subjects were divided into three groups: Group I with severe processing deficits often indicative of LD, Group II with moderate processing problems, and Group III with no significant problems. All subjects were administered the counseling form of the Tennessee Self-Concept Scale and the Self-Concept as a Learner Scale and participated in a 5 min. videotaped interaction with a same-sex experimental confederate.

Analyses indicated no significant differences among the groups on either of the self-concept scales, however trends were noted in the data. Group III tended to score lower on social subscales of both measures while scoring highest on task orientation and problem solving subscales. Analysis of the videotaped interaction also indicated no significant differences among the groups, however, Group III tended to talk more while directing fewer questions to the confederate. These results suggest that auditory/visual processing deficits may be related to social difficulties, although further research is necessary to substantiate the trends noted.

DEMONSTRATION OF PSYCHOLOGICAL AND SCIENTIFIC ERRORS IN RESEARCH AND PUBLICATIONS WITH THE PSYCHOLOGICAL STRESS EVALUATOR. Michael P. Kradz and John C. Bartone, The American Health Research Institute, Annandale, Virginia 22003.

The scientific methodology of a new instrument, the Psychological Stress Evaluator (PSE), is currently without standards in any field of published literature. Some scientists and courts of law praise the PSE while others condemn it. The instrument has been given validity and reliability tests. Hardware instrumentation cannot be faulted as designed. All software programs must be examined for improvement. Yet the PSE is often censured as an instrument while its use and management is abused and ignored. Many results, publications and seminars contain erroneous factors as (1) poor data collections; (2) maladapted instrumental operations; (3) incorrect voice recordings, (4) improper client or patient preparation (normal vs. psychosomas vs. neurotics vs. psychotics, et al.); (5) faulty interrogations of subjects; (6) irregular data sequence and alignment; (7) inaccurate judgments for continuance of interrogation of subjects or prisoners; (8) inapposite follow-up examinations (9) crude or non-existent de-conditioning of interrogatees; (10) coarse kymograph production; (11) invalid chart interpretations; (12) illogical and pseudopsychodiagnostics; (13) inadequate and unscientific reports; (14) poor attitudes of operators and interrogators; (15) unnecessary jeopardy for clients and incarcerated suspects, and (16) insufficient use and extension of operator faculties, supervision and control.

AGE, S-R COMPATIBILITY AND STIMULUS UNCERTAINTY EFFECTS ON INFORMATION PROCESSING. D. Michael McAnulty*. Dept. of Psychology, Old Dominion University, Norfolk, Va. 23508

This study was designed to assess the influence of the central, stimulus processing and response selection mechanisms on the consistently reported age decrement in information processing. Five younger (19-28, mdn = 22) and 5 older (69-78, mdn = 71) female subjects were recruited from univ. undergraduates and community organizations. Subjects were individually presented 32 trials at each of the 6 factorial combinations of 3 stimulus uncertainty (SU) levels (2, 4 or 8 equiprobable numerals) and 2 levels of stimulus-response (S-R) compatibility (high and low). On each trial, a single numeral was projected on a 1.5 inch square screen above a S-R configuration card. The subjects depressed a telegraph key associated with the presented numeral as rapidly as possible. Responses under high compatibility were in left to right ascending order. Under low compatibility, even numerals were randomly paired with the right hand keys and odd numerals were randomly paired with the left hand keys. The choice reaction time (CRT) was measured for each trial. Analysis of variance indicated that increased age, greater SU, and lower S-R compatibility each resulted in significantly (p <.01) slower mean CRT. All the interactions except those involving age and S-R compatibility were also significant (p<.05). The results indicated that the age decrement in information processing was primarily attributable to the central stimulus processing rather than the response selection mechanism.

PERSPECTIVE-TAKING ABILITIES OF NORMAL AND LEARNING DISABLED CHILDREN: DO YOU SEE WHAT I SEE? E. M. Justice*, and R. L. Beard*. Dept. of Psychology, Old Dominion Univ., Norfolk, VA 23508

The perspective-taking skills of normal and learning disabled (LD) children between 9 and 12 years of age were examined. The subjects were 44 children diagnosed as LD and 44 children without learning problems, matched with the LD sample on age, race and sex. Each child was tested on three perspective-taking tasks. Affective perspective-taking, awareness of another's feelings, was tested using stories and pictures that were (a) consistent ("getting a new toy" and a smiling face) or (b) inconsistent ("eating one's favorite ice cream" and a sad face). Perceptual perspective-taking, awareness of what another is seeing, involved judging another's view of a spatial array. Cognitive perspective-taking, awareness of what another knows, involved telling a story as it would be told by another.

Results indicated that both normal and LD children showed nearly perfect performance on the affective task when verbal and pictorial cues were consistent. When cues were inconsistent, LD children relied on pictorial cues while normal children relied on verbal information. The LD children scored significantly lower than the normal children on both the perceptual and cognitive tasks. These findings suggest that LD children are often ineffective in taking the perspective of others. Programs designed to develop perspective-taking skills may alleviate the social difficulties often experienced by children with learning problems.

THE EFFECT OF LEADERSHIP STYLE AND WORK ENVIRONMENT ON JOB RELATED BEHAVIORS. John K. Schmidt*. Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450 (Sponsor: L. E. Jarrard)

A study designed to examine Fiedler's contingency model of leadership effectiveness was conducted in a small unionized manufacturing plant in northern New Jersey. The research tested the effects of leadership orientation and specific work climates on performance (as was conducted in Fiedler's original studies), job satisfaction, absenteeism and turnover. It was found that performance is not the only work behavior that is contingent on the job situation, but that job satisfaction and absenteeism are also to be considered. Turnover proved to be only slightly important. Further, the job related behaviors themselves were observed as being connected with one another to varying degrees. Overall, the concept that effective leadership is based on appropriate matching of leadership orientation and work environment was upheld, and that more issues should be examined before judging leader effectiveness than just high productivity.

NORADRENALINE AND SPATIAL MEMORY IN THE RAT. Robert D. Shaver* and Thomas K. Creson, III*, Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450 (Sponsor: L. E. Jarrard)

Fourteen Sprague-Dawley rats were used to investigate the effects of general noradrenaline depletions on spatial memory. Noradrenaline was depleted by injecting 6-hydroxy-dopamine into the dorsal noradrenergic bundle, which is the main fiber bundle supplying noradrenaline to the telen-cephalon, especially hippocampus. All rats were trained preoperatively to run to 4 alleys of an 8-arm maze. Five rats were administered 6-hydroxydopamine, 5 rats served as sham operated controls, and 4 served as unoperated controls. Retention and reversal learning were investigated after the operations. The results will be discussed as they relate to the effects of noradrenaline depletions on spatial memory in rats.

METAMEMORY ABILITIES IN GOOD & POOR SPELLERS John Stathakis* Dept. of Psychology, Washington & Lee Univ., Lexington, Va.

This study investigated the relationship of memory monitoring abilities and spelling skills in 4th grade children. As in other metamemory studies, it was assumed that children who are unable to accurately predict how much they know are likely to devote less time to studying and thus show poorer performance. Groups of good and poor spellers were tested for general metamemory (Flavell, Friedrichs & Hoyt, 1970) and specific spelling metamemory (e.g., predicting the number of words they could learn to spell correctly in a 10 min. period). Strategies found useful by good spellers were then taught to half of the poor spellers. After 1 week, all subjects were tested for spelling metamemory on a new list.

It was found that poor spellers who received training did become more accurate in predicting their spelling performance. Although better spellers were found to have greater spelling metamemory abilities, no differences were found between groups on the general metamemory task. The results were interpreted in light of Markman's (1973) study of general metamemory and ability to predict performance on motor tasks. She suggests that metamemorial abilities do not emerge synchronously but vary depending upon familiarity and experience with the task. Thus, it is suggested that by familiarizing poor spellers with rules, and providing experience with spelling metamemory we might be able to bring poor spellers' ability up to a level congruent with their other metamemorial capacities.

THE WINGS OF THE MULLER-LEYER: AN IN-DEPTH REPORT. Joseph B. Thompson.* Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450

Eighteen subjects estimated the length and the location in depth of stereoscopically presented Muller-Leyer figures and straight lines. The results indicate that the presence and orientation of wings influenced length judgments, but did not affect depth judgments of either monocularly or stereoscopically presented stimuli, or of stimuli with stereoptic cues designed to complement or oppose the hypothesized perspective cues suggested by the wings. Vertical position of the target and binocular disparity influenced both length and depth judgments.

Statistics

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University

AN APPLICATION OF THE LISREL IV PROGRAM TO THE ANALYSIS OF HUMAN HALF-SIB DATA. R. M. Cantor* and W.E. Nance*. Dept. of Human Genetics, Med. Col. of Va., Richmond, Va. 23298
Monozygotic (MZ) twins have identical sets of genes and, thus, their offspring are related to each other as conventional half-siblings. Expectations of mean squares among half-sibships, between sibships nested within half-sibships, and within sibships yield five simultaneous equations which permit the estimation of additive, dominance, epistatic, environmental and maternal effects by iterated weighted least squares (Nance and Corey 1976). To date, all reported analyses have been on univariate traits.
Lisrel IV is a general purpose computer program developed by Jöreskog and Sörbom (1978) for maximum-likelihood estimation of coefficients in sets of linear structural equations under the assumption of multivariate normality. It supplies a large sample likelihood ratio goodness of fit test for structural models, and may be modified for the procedure of confirmatory factor analysis.
The program was employed to test multivariate models for inheritance of genes for finger ridge counts. Data were obtained from 430 offspring in the families of 39 male and 49 female MZ twins. Individual finger ridge counts were determined by the method of Holt (1968) and standardized prior to analysis. Simple additive genetic, random environmental models for total ridge count were readily rejected while more complex models assuming interactions between the determinants of individual finger ridge counts provided an adequate explanation for the data.

EVALUATION OF THE ESTIMATION OF PARAMETERS FOR THE GAMMA DISTRIBUTION USING THE MONTE CARLO METHOD. Susan R. Case* and J. Van Bowen. Dept. of Mathematics, Univ. of Richmond, Va. 23173.
Data supplied by the USFDA concerning the control of the cigarette bettle, Lasioder serricone, was the basis of the present research. The grouped data was provided by selecting k samples of beetles and subjecting each sample to a toxic gas for varying numbers of days. After the appropriate time interval, a count of the number of expired beetles provides k measurements of the number of expired (n_i) of the number tested (N_i) in the elapsed time (r_i, $i = 1, \ldots, k$).

PREDICTIVE INFERENCE FOR THE INVERSE GAUSSIAN DISTRIBUTION. Raj S. Chhikara*, Dept. of Mathematical Sciences, Old Dominion University, Norfolk, VA 23508
The problem of prediction intervals for the inverse Gaussian variable is studied and the β-expectation tolerance limits are obtained. Exact two-sided tolerance limits using the percentage points of χ^2 and F distribution are given. However, no closed form sampling theory solution is feasible for the one-sided limits. In this case, the β-expectation tolerance limits are obtained based on a predictive density function determined using the vague prior for the parameters. Numerical computations using two sets of life-time data are included.

SIMULTANEOUS TESTS FOR FINITE FAMILIES OF HYPOTHESES. Robert V. Foutz*. Dept. of Statistics, Va. Polytechnic Inst., Blacksburg, VA 24061
A procedure is proposed whereby R test statistics $\underline{F}$ = $(F_1, F_2, \ldots, F_R)$ together with "randomly generated critical points" $(C_1, C_2, \ldots, C_R)$ may be used to construct a simultaneous test for a family containing R hypotheses. This procedure provides simultaneous tests having an exact prescribed type I error rate; the procedure does not require the distribution of $\underline{F}$ to be known. The simultaneous test is illustrated for making all pairwise comparisons in a one-way ANOVA model.

THE EFFECTS OF STATISTICAL CRYPTANALYSIS IN WORLD WAR II. I.J. Good, Dept. of Statistics, Va. Polytechnic Inst. & State Univ., Blacksburg, Va. 24061.

It seems possible that the most important use that has ever been made of statistics was for cryptanalysis in World War II because without it perhaps the world would have been conquered by a criminal lunatic whose name was appropriately an anagram of THE LIAR and of HEIL RAT. Statistics, however, is only one of the tools used by the cryptanalyst.

The details of the methods used have apparently not yet been declassified so this presentation will deal largely with the effects of the work, much of which have been published in recent years, as, for example, in Ronald Lewin's book ULTRA GOES TO WAR.

The statistical techniques included sequential analysis, Bayesian methods, and tree searches, none which had been officially used much before the war (although chess players had informally used tree searches for centuries). A. M. Turing was influential in much of this work. Two types of large cryptanalytic machines were built. The first, called the Bombe, was electromagnetic. A primitive form of this machine had previously been used by Polish cryptanalysts. The second large machine, the Colossus, was electronic with 1500 tubes and was in many respects a precursor of the general-purpose electronic computer. The first Colossus began operation on 1943 June 1, five days before D-day, the successful Allied invasion in Normandy.

THE COMPARISON OF SEVERAL MULTINOMIAL DISTRIBUTIONS WITH A STANDARD. Mark O. Marcucci and D. R. Jensen. Dept. of Statistics, Va. Polytech. Inst. and State Univ., Blacksburg, VA. 24061.

Suppose independent random samples have been taken from k+1 multinomial distributions having c classes each, of which one distribution is considered a standard. It is desired to test whether each of the remaining distributions differs from the standard. A multiple test procedure is described using Pearson's chi-square test statistics on the $cx2$ tables formed by pairing each test distribution with the standard. The limiting joint distribution of these statistics is a multivariate chi-squared distribution which yields approximate critical values for the given tests at level α. Some probability inequalities relating to the testing procedure are discussed. For the case of binomial distributions approximate critical values are available from the literature. Applications are noted in biology and statistical quality control.

HYPOTHESIS TESTING IN B-SPLINE REGRESSION. Patricia L. Smith, Dept. of Mathematical Sciences, Old Dominion Univ., Norfolk, VA 23508

Linear combinations of B-spline coefficients which provide statistically meaningful hypothesis tests are identified. These tests include the importance of breakpoints, continuity constraints, and higher order terms. The important linear combinations turn out to be contrasts whose coefficients are determined by differencing the left- and right-hand limits of the B-splines or their derivatives at certain knots. A FORTRAN program for testing single degree of freedom hypotheses is discussed. (Partially supported by Old Dominion Univ. Summer Research Faculty Fellowship #80-950).

BAYESIAN STATISTICS, THE LAW, AND QUANTITATION OF ILLEGAL HASH OIL. P. J. Smith*. Dept. of Biostatistics, Med. Col. of Va., Richmond, Va. 23298

In Virginia, possession of hash oil having tetrahydro-cannabinol (THC) content exceeding 12% corresponds to a felony whereas hash oil containing less than 12% THC corresponds to a misdemeanor. This paper presents an experimental design by which serial dilutions of increasing TCH concentration may be calibrated with the relative response of each solution as measured by gas chromatography (GC). Also, of interest is the assessment of the hypothesis that a given sample of specified GC response has THC content less than 12%. Bayes factors and posterior expected utility ratios are given to evaluate the hypothesis.

USE OF THE POWER TRANSFORMATION IN THE INTERPRETATION OF MUTAGENESIS TEST DATA. R. D. Snee, Engineering Dept., and J. D. Irr, Haskell Lab., E. I. du Pont de Nemours & Co., Inc., Wilmington, DE 19898

Mutation tests, such as the Ames, mouse lymphoma, and Chinese hamster ovary, are rapidly becoming a widely used tool for screening chemicals for cancer producing potential. It is shown that the power transformation, $Y = (\text{mutation frequency} + A)^\lambda$, with parameters estimated by the method of Box and Cox, enables one to use standard analysis of variance and regression techniques in the evaluation of the results of these tests. The recommended power transformation parameters are $A = 0$, $\lambda = .2$ for the Ames test, $A = \lambda = 0$ (log transformation) for the mouse lymphoma assay, and $A = 1$, $\lambda = .15$ for the Chinese hamster ovary test. These results were obtained by analyzing data from these tests collected by different laboratories on a wide variety of chemicals. Aspects of the Box-Cox estimation procedure which need further research are also discussed.

NOTES

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Nectar Dispersion Patterns in a Population of Impatiens capensis

Michael Zimmerman

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Abstract—An analysis of the nectar dispersion pattern of a popula-
tion of *Impatiens capensis* demonstrated that patches of flowers with
similar standing crops of nectar exist. The implications of this pat-
tern on the foraging behavior of nectar feeding pollinators is dis-
cussed and it is predicted that pollinators should utilize an area
restricted searching pattern. Such a foraging pattern would facilitate
pollen dispersal by chasmogamous flowers.

Introduction

An integration of pollinator foraging behavior and
plant reproductive strategies is critical if we are to fully
understand the coevolutionary pressures impinging on
the participants in these systems. Pollinators are under
strong selection pressure to maximize their rate of net
energy intake while foraging (cf. Pyke *et al.,* 1977) and
plants are under similar pressure to maximize their
reproductive output. Pollinator foraging behavior can
be influenced by a number of plant characteristics
which may vary between plant populations. For
example, as interplant distances increase, pollinator
flight distances also increase (Levin and Kerster,
1969a, b; Zimmerman, 1981b). As floral arrangement
becomes more unpredictable (i.e., as large numbers of
flowers are scattered over a plant instead of being
packed onto a single inflorescence) pollinators stop
incorporating a directionality component into the
foraging strategy (Zimmerman, 1979a, b), and, in a
number of plant species, the amount of reward received
influences subsequent foraging movements (Pyke,
1978; Hartling and Plowright, 1979a, b; Pleasants and
Zimmerman, 1979; Zimmerman, 1979a, 1981a, b).
While there have been a great number of studies which
have characterized the nectar production rates of plant
species there have been relatively few studies which
have attempted to describe the dispersion pattern of
standing crop of nectar for a population (Pleasants
and Zimmerman, 1979; Zimmerman, 1979a, 1981a, c).
Examining nectar dispersion patterns is of interest
because when patches of flowers with similar standing
crops exist it has been predicted (Pyke, 1978; Pleasants
and Zimmerman, 1979; Zimmerman, 1979a) that pol-
linators should forage utilizing an area-restricted
searching behavior. Basically, this behavior consists of
foragers reacting to nectar volumes encountered by
having their interflower (or interplant) movement dis-
tances negatively correlated with the amount of reward
received at a flower.

The coevolutionary implications of such a correla-
tion are striking. Zimmerman (1981c) has shown that
foragers utilizing an area-restricted searching behavior
will actually create a patchy resource base and thus

reinforce such foraging. He has further demonstrated
(Zimmerman, 1981a) that such a foraging strategy will
increase the neighborhood size of the plant population
by having pollen grains transported long distances
after pollinators encounter flowers with little standing
crop of nectar. An increase in neighborhood size can
be of evolutionary significance to plants because, as
Schaal (1980) has shown, in situations when pollina-
tors move predominately between nearest neighbors,
neighborhood size may be very restricted. Random
events associated with small populations may thus be a
dominant evolutionary force under such conditions.
As neighborhood size increases random events play a
much less significant role.

The present study characterizes the nectar disper-
sion pattern for a population of *Impatiens capensis*
Meerb. (Balsaminaceae) and demonstrates that flow-
ers with similar nectar volumes are often associated
with one another, i.e., that nectar patches exist. This
work is thus a preliminary step towards characterizing
floral rewards and predicting pollinator behavior as
well as seeing how widespread area restricted searching
behavior is in plant/pollinator systems.

Methods

The fieldwork was conducted on 12 September 1980
utilizing a roadside population of *Impatiens capensis*
located approximately 12.5 km west of the town of
Oberlin, Ohio. *I. capensis* is an annual producing both
chasmogamous and cleistogamous flowers (Schemske,
1978). The orange-colored chasmogamous flowers are
approximately 16.4 mm long with an 8.3 mm nectar
spur (Schemske, 1978) and are primarily pollinated by
the bumblebee *Bombus vagrans* (Rust, 1977; Schemske,
1978).

Flowers, chosen at random, had their standing crop
of nectar measured by slitting open the nectar spur and
removing all available nectar with a $5 \mu l$ capillary tube.
The 162 flowers sampled in this manner were termed
subject flowers. Standing crop of nectar was also mea-
sured for the two nearest neighbors of each of the
subject flowers. Nearest neighbors were within 0.5
meters of subject flowers. In all, 486 flowers were
sampled.

The mean nectar volume for all sampled flowers was
calculated. This value was then used to distinguish
between two classes of flowers: "cold" flowers had
equal to or less than the mean while "hot" flowers had
greater than that amount of nectar. A 2×2 contingency
table was then created. The cells of this table indicated

the frequency with which either a hot or a cold subject flower had either two cold nearest neighbors or at least one hot nearest neighbor. A Chi square test corrected for continuity was performed on the data to see if subject flowers and nearest neighbor flowers with similar nectar volumes were associated with one another. A second table using the *median* nectar volume of all sampled flowers to distinguish between hot and cold blossoms, was also created. Additionally, correlation coefficients were calculated for nectar volumes in subject flowers and first nearest neighbors as well as between subject flowers and second nearest neighbors.

Results and Discussion

The results of the nearest neighbor analysis are presented in Table 1. Both the mean and the median criteria yielded similar results. Both the mean and the median were chosen because although it is not clear exactly how pollinators go about assessing the quality of their environment it is reasonable to suspect that pollinators would use a relative rather than an absolute value as well as one that relates to the central tendency of the nectar distribution in question (Charnov, 1976; Zimmerman, 1981c). In both cases hot subject flowers were associated with hot nearest neighbors while cold subject flowers were associated with cold nearest neighbors. These results mean that nectar resources in *I. capensis* are patchily distributed and the amount of nectar found in one flower can be successfully used to predict the amount of nectar expected in a nearby flower. This predictability is further demonstrated by the correlation coefficients between nectar volumes in subject flowers and first and second nearest neighbors (r = 0.432, P<0.01, r = 0.374, P<0.01, respectively; N = 162).

Demonstrating a patchy nectar distribution in *I. capensis* is not equivalent to demonstrating the cause of that distribution. The dispersion pattern observed might be due to the foraging patterns of pollinators or due to the fact that nearest neighbor flowers were almost invariably on the same individual and therefore may have had similar nectar production rates. The cause of the pattern, for the moment however, is irrelevant. What is important is the effect that such a pattern will have on the subsequent foraging behavior of nectar feeding pollinators.

If one assumes, as do all models of optimal foraging, that pollinators forage in a manner which maximizes their rate of net energy intake (cf. Pyke *et al,* 1977) then nectar patches of the sort described in *I. capensis* should lead to a particulr type of foraging behavior. Because the probability of encountering a hot flower near another hot flower is quite high, pollinators, after encountering one such flower, should next move to a near-by flower. Similarly, because the probability of encountering a hot flower near a cold flower is low, a pollinator, after encountering a cold flower, should move a greater distance and leave the cold patch. More specifically, patchiness in nectar should lead to area-restricted searching on the part of pollinators.

Area-restricted foraging has been reported in four studies of nectar feeding pollinators. Pyke (1978) demonstrated such behavior by *Bombus appositus* queens foraging on *Delphinum nelsonii* (Ranunculaceae), and *B. flavifrons* workers foraging on *Aconitum columbranum* (Ranunculaceae). *Bombus* spp. workers and queens utilize the same strategy when foraging for nectar on *Thermopsis montana* (Leguminosae) (Zimmerman 1981a) and Gill and Wolf (1977) have shown that sunbirds (*Nectarina* spp.) react to varying amount of nectar in *Leonotis nepetiflora* (Lamiaceae) in a similar manner. The underlying resource distribution was examined in the cases of *D. nelsonii* and *T. montana* and was found to be patchy in both cases (Pleasants and Zimmerman, 1979; Zimmerman, 1979a, 1981a,c). The present study, then, is only the third report on the nectar dispersion pattern of a plant population. In all three cases a patchily distributed resource base was found.

The pattern of nectar dispersion in *I. capensis* strongly suggests that optimally foraging bumblebees should be utilizing an area-restricted searching pattern. Confirmation of this prediction awaits detailed observations of bumblebees on this species.

It should also be noted that flower presentation on *I. capensis* is quite different than on the four above mentioned plant species. Flowers on *I. capensis* are produced singly and are scattered over the plant while the other four species produce relatively dense inflorescences. Since it has been shown that the method of flower presentation can influence some aspects of foraging behavior (Zimmerman, 1979a,b) it is interesting that the predicted optimal strategy on *I. capensis* is similar to that on the other species. These results at least suggest that area-restricted searching may be a very common strategy employed by pollinators.

Finally, the advantage to the plant of having pollinators utilize an area-restricted searching behavior can be discussed. *I. capensis* produces both chasmogamous and cleistogamous flowers. Since the cleistogamous flowers produce seeds in the absence of pollinators and at a lower energetic cost than do the chasmogamous flowers, it has been hypothesized (Schemske, 1978) that the chasmogamous flowers serve to increase outbreeding. Waller (1980) reports that chasmogamous flowers are produced on the periphery of the top branches making them both conspicuous and available to pollinators. Additionally, the fact that flowers remain in the male phase approximately five times longer than in the female state produces functional monoecy and thus probably promotes outcrossing as well (Schemske, 1978). The patches of nectar found in the present study can also be seen as an aid to outbreeding. The long moves associated with poor quality patches tend to increase neighborhood size (Zimmerman, 1981a) and thus increase pollen dispersal. This increased dispersal distance will lower the probability of geitonogamous fertilization occurring and promote greater genetic variability among the seeds of chasmogamous flowers relative to cleistogamous ones.

TABLE 1

Relationship between the reward value of subject flowers and their nearest neighbors. All flowers which had more nectar than the appropriate value for distinguishing between hot and cold flowers were considered hot while all others were considered cold (Mean = 0.55 μl; Median = 0.40 μl).

Value for Distinguishing Between Hot and Cold Flowers

	Mean		Median	
	SUBJECT FLOWERS			
	Hot	Cold	Hot	Cold
Two nearest neighbors:				
Hot and Hot or				
Hot and Cold	47	36	69	35
Cold and Cold	21	58	20	38
	$X^2 = 13.79$		$X^2 = 14.01$	
	$P < 0.0001$		$P < 0.0001$	

Acknowledgements

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Dextroamphetamine Affects Hypothalamic-Pituitary-Thyroid Activity: A Preliminary Study

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Abstract—The daily subcutaneous injection of 10 mg/kg BW d-amphetamine sulfate (AS) into both male and female rats over a three week period reduced the storage and secretion of thyrotropin (TSH) without affecting serum thyroxine (T_4) concentrations. Hypothalamic content of thyrotropin releasing hormone (TRH) was also depressed following AS treatment. Thus, it is hypothesized that the decline in pituitary thyrotrope activity during AS treatment resulted from a supression of TRH synthesis and release from the endocrine hypothalamous.

Introduction

Amphetamines have been used as an appetite suppressant (Anderson, 1974; Sapeika, 1974; Innes & Nickerson, 1975; Valverde-R *et al.*, 1976) and CNS stimulant (Sapeika, 1974; Weiner, 1980; Valverde-R *et al.*, 1976) in humans. However, a review of the literature reveals little work has been done regarding the effect of this drug on hypothalamic-pituitary-thyroid activity (HPTA). Melander, *et al.* (1976) reported that euthyroid patients, treated with amphetamines because of mental illness, displayed significant elevation in blood titers of T_3 and T_4 without corresponding changes in pituitary TSH secretion. On the other hand, Valverde-R, *et al.*, (1976) claimed that amphetamine blunted the normal increases in TSH and the decreases in T_4 in the circulation of humans during sleep. Knigge (1974) reported that one hour of incubation with 1 mg/ml amphetamine virtually depleted the rat median eminence of TRH. The variations in these results are no doubt due in part to difference in experimental protocol. The present study was conducted to determine whether or not long term administration of d-amphetamine affects the HPTA in maturing laboratory rats.

Materials and Methods

Five-week-old Sprague-Dawley litter mates were either left intact or injected sc, daily, with 10mg/kg BW dextroamphetamine sulfate (AS) (Dexadrine, 5mg/ tablet, lot 146-E19, Smith-Kline & French, dissolved in distilled water). The rats were fed Purina chow chex and maintained under controlled temperature ($22\pm1°$C) and artificial lighting (lights on 0600 to 1800 hours). After three weeks the rats were decapitated and sera and extracts of anterior pituitaries and hypothalami obtained as previously described (Ching, *et al.*, 1974, Knigge, *et al.*, 1974). Serum and pituitary concentrations of TSH and T_4 were quantified by radioimmunoassay in the manner previously reported

(Ching, *et al.*, 1974, 1975) whereas hypothalamic content of TRH was measured by bioassay (Knigge, *et al.*, 1974).

Results and Discussion

In terms of body weight equivalence, the daily dose of 10mg/kg AS is approximately 25 times the recommended oral dose for humans (Weiner, 1980). Nevertheless, various studies have been performed in rats in which doses as high as 20 - 64mg/kg/day for 2 - 4 weeks, were used (Tormey & Lasagna, 1960; Lewander, 1971). However, these studies were mainly concerned with the effects of amphetamines on self stimulation behavior, appetite suppression and changes in body weight, alterations in body temperature, locomotor activity, stereotypic behavior, etc. and not with the hormonal effects relating to thyroid activity.

In the present study, the daily injections of AS to male and female rats for 3 weeks caused reductions in both the serum and pituitary concentrations of TSH and in the hypothalamic stores of TRH (Table 1). Serum T_4 titers and thyroid weight and growth, as indicated by the gain in body weights remained unchanged from normal following chronic AS treatment.

The decreased levels of serum TSH observed in the AS-treated rats were not attirbutable to an enhancement of the negative feedback by T_4 since the latter's concentration in blood were not increased over normal. Averill (1969) has reported that full suppression of the pituitary response to TRH might require pre-treatment with supranormal doses of T_4. Although TRH release rates were not assessed in the present study, the reduction in bioassayable TRH contained within the hypothalamus, coupled with the decrease in the storage and secretion of pituitary TSH, suggest that AS treatment caused a decline in hypothalamic TRH synthesis and/or secretion.

It should be mentioned that Vale, *et al.* (1974) reported that 2-10ug somatostatin (SRIF) reduced the TRH-induced pituitary secretion of TSH in mice prepared for TRH bioassay. Thus, this quantity of SRIF, if present in the hypothalamic extracts of AS-treated rats, could account for the reduction in the bioassayable TRH content. However, recent studies in our laboratory revealed that the hypothalamus-median eminence complex of normal and drug-treated two-month-old male and female SD rats contained 200-

1300 pg radioimmunoassayable SRIF (unpublished observation). Higher concentrations of SRIF have been reported by other investigators (Brownstein, *et al.* 1975; Patel & Reichlin, 1978). However, even at the hypothalamic contents of 39-77ng SRIF reported by these groups, less than 213 ng SRIF would have been administered to the bioassay recipients which is approximately one-tenth the minimal effective dose of SRIF required to inhibit the pituitry secretion of TSH.

Thus, all things considered, the available results do not support the notion that amphetamine increases the secretion of TRH as previously reported by Knigge (1974). If amphetamine did increase the secretion of TRH this could account for the lower TRH stores but would also introduce the possibility that the drug blocked the TRH-induced release of TSH. In an effort to clarify this controversy, attempts will be made to quantitate hypothalamic TRH secretion into hypophyseal portal blood of the AS-treated rat in the manner previously reported (Ching & Utiger, 1980).

TABLE 1

Body and thyroid weights, and storage or serum concentrations of TSH, T_4 and TRH in male and female rats treated with d-amphetamine sulfate as compared to normal controls. Data represent means±SEM. Cerebral cortex control tissue contained no detectable TRH.

Group	Sex	No.	BW (g)	TW (mg)	TSH Serum (mU/dl)	TSH Pituitary (mU/mg)	T_4 Serum (ug/dl)	TRH Hypothal. (ng)
NC	M	9	262±15	17.9±1.6	14±4	14.9±1.9	5.5±0.6	2.6±0.1
AS	M	7	257±12	16.5±1.7	3±1*	6.3±1.9+	5.3±0.6	1.0±0.2+
NC	F	9	199±5	16.1±1.6	13±3	13.1±1.3	4.5±0.7	2.4±0.3
AS	F	7	192±4	15.4±0.7	3±1*	9.9±2.9	----	1.3±0.3#

Significance from NC: # p<0.05;　　* p<0.02;　　+ p<0.01

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Inactivation of Poliovirus-2 in Natural Waters: A Thermolabile Factor[1]

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Abstract—The inactivation of poliovirus-2, strain W-2, in filter sterilized surface ocean water was found to be biphasic at 17°C with the initial rate 7-fold greater than the secondary inactivation rate. These rates were greater than that for deionized water and less than for an artificial seawater with higher pH and salinity. By increasing the pH and/or salinity of ocean water to that of the artificial seawater, the inactivation rate increased. Autoclaving filter sterilized ocean water resulted in the loss of a virus inactivation component and prolonged inactivation kinetics. Capsid polypeptide alterations were detected by polyacrylamide gel electrophoresis following long incubations of virus in filter sterilized ocean water but not in autoclaved ocean or deionized waters. An inactivation component in filter sterilized ocean water was concentrated by thin channel ultrafiltration. The concentrated activity increased the rate of Po-2 inactivation 20-fold, was heat sensitive, nondialyzable, and inactivated at pH below 3.2 and above 11.0. The presence of protein in the concentrate was confirmed by gel electrophoresis and protein analyses.

Introduction

Human enteric viruses are produced in large numbers and become associated with wastewaters from which they may be readily isolated. More than a hundred serotypes predominately members of the picornaviridae (polioviruses, coxsackieviruses, and echoviruses) as well as the adenoviridae, reoviridae and less well characterized gastroenteritis viruses, the rotaviruses, and the causitive agent of infectious hepatitis are known to frequent wastewaters and are thought to be transmitted by means of the water route (Melnick, 1978). As a consequence of wastewater treatment procedures designed predominately for the reduction of fecal coliform numbers and not enteric and related viruses, viral infectious agents may readily be detected and isolated from outflows and in receiving waters downstream from outflows (Berg, 1973).

The fate of viruses in the aqueous environment is subject to numerous variables. Evaporative processes associated with bubble ejection or aerosols are virucidal (Ward and Ashley, 1977). Ultraviolet irradiation and thermal effects contribute to virus inactivation (Akin et al., 1971). Particle adsorptive phenomenon (electrostatic interactions-trapping) contribute to the removal of virus from water by transfer to the sediment. In laboratory studies the proteolytic activities emanating from several genera of bacteria are responsible for virus inactivation (Cliver and Herrimann, 1972). The relative significance of each of these is not known for any environmental situation.

Experiments conducted in natural fresh waters using laboratory strains of purified viruses indicate that virus inactivation rates are predictable as a direct function of the temperature (O'Brian and Newman, 1977). Irreversible inactivation of virus is accompanied by damage to the viral RNA. Since the viral capsid surrounds or contains the viral nucleic acid, it has been suggested that two temperature dependent processes may be involved in the inactivation of single stranded RNA viruses. The first is a modification in the capsid structure exposing the nucleic acid to the environment, and the second is a cleavage event serving the phosphodiester linkage of the viral RNA. (Ward and Ashley, 1976; O'Brian and Newman, 1977).

The report describes the inactivation of the single stranded RNA virus, poliovirus-2, in filter sterilized marine surface waters obtained from the shorelines of beaches and recreational waters in the Tidewater area of Southeastern Virginia.

Materials and Methods

Cells and Virus Propagation. Poliovirus, type 2, strain W-2 (hereafter designated Po2), obtained from the American Type Culture Collection, (VR-301) was plaque purified and utilized in all experiments. African green monkey kidney cells (AGMK; American Type Culture Collection certified cell line 7.1) were cultured in an autoclavable minimal essential medium (Flow Laboratories, Inc.) containing 10% fetal calf serum and antibiotics (penicillin and streptomycin). Cells were incubated at 37°C in an atmosphere containing 5% CO_2 and 95% relative humidity. The stock of poliovirus was prepared from a lysate of AGMK cell monolayers infected with a multiplicity of infection (m.o.i.) of about 1 particle per cell. The growth media, cells, and cell debris from the Po-2 infection were rapidly frozen at -60°C and thawed 3 times. The lysate was centrifuged at 15,000 xg for 10 min at 4°C. The supernatant containing the virus was centrifuged for 2.5

Footnotes

hours at 40,000 rpm in a 60-Ti Beckman rotor at 4°C. The resulting pellet was resuspended in tryptose phosphate broth (Gibco) and sonified using a Bronson Model 6 ultrasonifier. The suspension was passed through a 0.22 micron filter and adjusted to a titer of about 2×10^7 pfu/ml.

Poliovirus Plaque Assay. AGMK cells were grown to confluence in Falcon tissue culture dishes (20 cm²). Serial dilutions of samples were made in Earle's balanced salt solution (EBSS; Flow Laboratories, Inc.) containing 2% fetal calf serum and aliquots were added to EBSS-washed confluent cultures. The adsorption volume was 0.4 ml and the plates were incubated with agitation at 15 min intervals during a 75 min adsorption period. Following adsorption, the inoculum was removed and the cells overlayed with complete growth medium containing 1.5% Bacto agar (Difco). Plaques were counted after 75 hours with the aid of neutral red staining of vital cells.

The linearity of the dose response curves was determined for Po-2 suspended in each of the selected waters. A linear dose response curve was obtained for each sample up to 40 plaques per plate. All viral titers were calculated from the slope of the linear region of the dose response curve.

Water Collection Sites. Grab samples (2 liters) of surface waters were obtained from the Atlantic Ocean surf at a beach 500 m to the North of Rudee Inlet in Virginia Beach. Deionized water was obtained from an 18 megohm resistance continental deionizing system. A Pall ultipore 0.22μ filter was in line with the outflow. Artificial sea water was prepared from Instant Ocean salts and was found to have an unadjusted pH of 9.1. All water samples were stored at 4°C in sterile glass containers and passed through prewashed 0.45 micron membrane (Nalgene) filters. Samples of these waters were analyzed for chemical content or inoculated with poliovirus within 2 days after collection.

Chemical Analysis of the Filter-Sterilized Waters. The hydrogen ion concentration in each of the filtered water samples was determined using a Corning pH meter with a calibrated hydrogen ion electrode. The salinity of the samples was determined using an American Optical refractometer or conductivity meter.

Purification of Radiolabeled Poliovirus. ¹⁴C-labeled poliovirus was prepared by a modification of the procedures described by Ward and Ashley (1976). Confluent AGMK cultures in 150 mm Falcon petri dishes were washed three times with EBSS and incubated at 37°C in EBSS for an additional 2 hours. The EBSS was removed and 4.0 ml of labeling medium (95% EBSS, 4.5% autoclavable MEM (minimum essential medium; Flow Labs), 0.5% dialyzed fetal calf serum and 17 mCi/ml of a uniformly labeled ¹⁴C-algal protein hydrolysate (specific activity 100 Ci/mmole) (New England Nuclear Corp.) was added. Poliovirus-2 was then added at a m.o.i. of greater than 3.0 pfu/cell and incubated for one hour. An additional 4.0 ml of labeling medium minus ¹⁴C-amino acids was added to each plate. The plates were incubated for 20 hours or until complete cell lysis occurred. The media and cell debris were collected and 3 times frozen and thawed. The mixture was centrifuged at 10,000 xg for 10 min and the supernatant fraction centrifuged in a Beckman 60-Ti rotor at 40,000 rpm for 2.5 hours. The pellet which contained most of the virus was resuspended in 1.0 ml of phosphate buffered saline (PBS; Gibco). The suspension was sonicated then mixed with an equal volume of n-butanol and shaken vigorously. The phases were separated by centrifugation at 100 xg for 10 min at 4°C. The butanol phase was removed by aspiration and the aqueous phase was re-extracted twice more with n-butanol. The butanol phases were pooled and extracted with 5 ml of PBS. All aqueous phases were combined (6.5 ml) and applied to a 10 to 30% w/w linear sucrose gradient (32 ml) in PBS. The gradients were centrifuged for 2.5 hours at 26,000 rpm in a SW-27 rotor at 4°C. Fractions (1.0 ml) were collected and monitored for radioactivity. Fractions containing the majority of radioactivity and with sedimentation coefficients between 150 to 160 S as determined by the method of McEwen (1967) were pooled, dialyzed against phosphate buffered saline, titered, and stored at -20°C.

Polyacrylamide Gel Electrophoresis. Poliovirus capsid proteins were separated by sodium dodecyl sulfate (SDS) polyacrylamide gel electrophoresis according to the procedure described by Baum et al. (1972). Radiolabeled poliovirus proteins and standard molecular weight marker proteins were placed in the adjoining wells of 10% acrylamide slab gels and run for 3 hours at 20 ml or unit the phenol red marker moved to the end of the gel. The gels were stained overnight in Coomassie brilliant blue, then destained in a solution of acetic acid (10%) and methanol (40%). The lanes containing radioactivity were cut into 1 mm sections. Each section was hydrolyzed in hydrogen peroxide then analyzed for radioactive content according to the procedure of Gerard et al. (1972).

Samples of ¹⁴C-Po-2 from each virus inactivation experiment were made to 10% in trichloracetic acid, incubated for 30 min on ice, then collected by centrifugation at 33,000 xg for 30 min at 4°C. The supernatants were discarded and the pellets washed twice with cold acetone and once with ether. Each washing was followed by centrifugation at 35,000 xg for 20 min at 4°C. These acid precipitated and washed samples were applied to gels for anlaysis of polypeptide content.

¹²⁵I-BSA samples from incubation studies did not require concentration and were applied to the lanes of gels directly.

Radioiodonation of BSA. Bovine serum albumin, fraction V, was labeled with ¹²⁵I according to the procedure of Hunter (1967). The labeled protein was stored at -20°C until use.

Results

Inactivation of Poliovirus-2 in filter sterilized waters. The inactivation kinetics at 17°C of Po-2 in filter sterilized and/or autoclaved, filtered sterilized ocean, deionized or artificial seawater is presented in Figure 1. The initial rate of inactivation of Po-2 in filter sterilized

artificial seawater was about seven times as rapid as that for deionized water and about the same as found for ocean water (Figure 1A). The inactivation was apparently biphasic in ocean water. Whereas 3 to 4 days were required to inactivate half of the virus during the initial rate of Po-2 inactivation, 14 to 22 days were required during the second phase of inactivation. Approximately 70 to 90% of the total infectivity was inactivated during processes involved in the initial
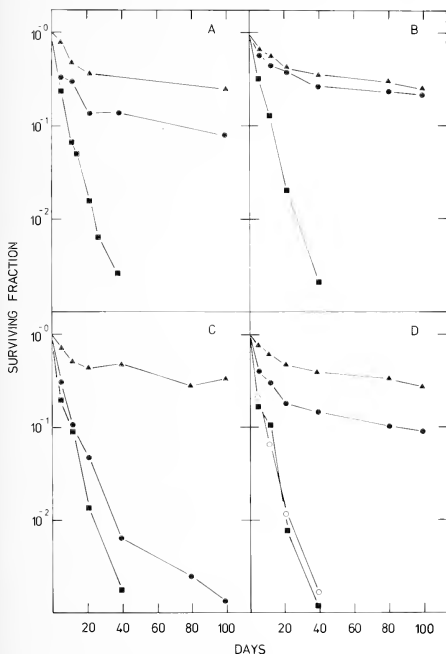

rapid inactivation phase, the remainder during the second phase. After 102 days of incubation, over 25% of the input Po-2 plaque forming units (pfu) survived in deionized water, and about 8% of the input virus survived in ocean water. No viable Po-2 infectivity was detected after 60 days of incubation in artificial sea water. At 222 days (not shown) virus infectivity was found in deionized water (0.72%) but not in ocean water.

A significant reduction of Po-2 inactivation occurred in autoclaved, filter sterilized ocean water (Figure 1B). This change amounted to a 5-fold decrease in the measured initial rate when compared to filter sterilized ocean water. The secondary rate for Po-2 in ocean water was the same as for deionized water. The inactivation rates for the autoclaved artificial sea and deionized waters (Figure 1B) were not significantly different from those of the respective, non-autoclaved waters (Figure 1A).

By adjusting the pH of autoclaved, filtered ocean water to that of the artificial seawater (pH 9.1) the rate of inactivation increased nearly to that for artificial seawater (Figure 1C). By adjusting both the pH and salinity the inactivation of Po-2 in autoclaved, filtered ocean water was found not to differ from that of artificial seawater (Figure 1D). The apparent result of these experiments was that both a relatively high pH and salinity contribute to Po-2 inactivation while heating filter sterilized ocean water contributes to a reduction of inactivation.

A possibility exists that some factor in the water samples could interfere with the plaque assay by inhibiting plaque formation. In order examine this possibility, a control experiment was designed to test for the presence of plaque assay interfering materials in each of the water samples. Plaque assay plates were each

TABLE 1

Effect of Filtered Water Samples on Plaque Formation

Preinoculation medium[a]	Plaque Formation (log $_{10}$ pfu/ml)
Cel culture media[b]	3.90
Deionized water	3.93
Artificial seawater	3.90
Atlantic Ocean water	3.76
Atlantic Ocean water (autoclaved)	3.71
No preincubation	3.79

[a]Standard poliovirus plaque assays were performed using a 6.5 × 10^3 pfu/ml stock of confluent 60 mm dishes containing AGMK cells. Culture media was separated and the cell sheet washed once with 2.0 ml of the respective 0.45 μ filtered preinoculation medium. The dishes were incubated 75 min with 0.4 ml of preinoculation medium, the media removed by aspiration, and 0.4 ml of a poliovirus dilution in 2% fetal calf serum and EBSS added. After a 75 min adsorption period, the inoculum was removed and replaced by complete growth medium containing 1.5% agar. Plaques were counted at 3 days.

[b]Eagles modified minimal essential medium containing 10% v/v fetal calf serum.

FIG. 1—Poliovirus-2 inactivation in autoclaved and/or filter sterilized water. Samples of each water, ocean, artificial sea water, or deionized, were inoculated at 2.2 × 10⁴ pfu/ml from a stock of virus at 2.2 × 10⁷ pfu/ml. The inocula, in sterile screw cap, polypropylene tubes were incubated at 17°C ± 0.2 in darkness for the indicated times until virus assay.

Panel A. Virus inactivation in filtered water. ▲ — ▲, deionized water, pH 6.9, 0.00 parts per thousand (ppt) as salinity; ● — ●, surface ocean water, pH 8.2, salinity 19.5 ppt; ■ — ■, artificial seawater, pH 9.1, salinity 31.0 ppt.

Panel B. Inactivation in autoclaved, filtered water. All symbols as in Panel A, each water sample was autoclaved.

Panel C. Inactivation in pH adjusted ocean water. Ocean water was filtered, autoclaved, and pH adjusted to 9.1 with sterile NaOH. Articial seawater and deionized water were autoclaved and filtered. Symbols are as in Panel A.

Panel D. Inactivation in pH and salinity adjusted ocean water. Autoclaved, pH adjusted ocean water (pH 9.1) as in Panel C was made 31.0 ppt in salinity using an autoclaved, filtered stock of artificial seawater. Autoclaved symbols as in Panel A. O — O, pH and salinity adjusted ocean water.

mock infected for 1 hr with one of the filtered water samples in the absence of added Po-2. The mock infected places together with other assay plates were then exposed to a known amount of Po-2 in a standard plaque assay (Table 1). With the close agreement of the controls and experimental virus titers, inhibitor-mediated plaque reduction was either reversible over the span of the experiment or was not present.

Because of the adsorptive behavior of polioviruses, container interactions were studied for the possible removal of infectious Po-2 from the water. Polypropylene centrifuge tubes each containing one of the 0.45 micron filtered waters were seeded with 1×10^3 cpm/ml of a highly purified, ^{14}C-labeled Po-2 stock and incubated at $17°$C for 1.0 hr or 14 days. The contents of each tube were assayed for radioactivity following incubation. The walls of the tubes were subsequently rinsed with 0.01 M Tris-HCl, pH 9.0, containing 0.1% sodium dodecyl sulfate. This procedure was found to desorb picornaviruses from container walls (J.C. Johnson, unreported observation). For each water sample, between 76.0% (deionized water) and 98.3% (ocean water) of the input radioactivity was found in the aqueous fraction, (Table 2). Virtually all of the radioactivity unaccounted for in the aqueous phase was recovered in the SDS wash of each tube.

Proteolytic activity in filtered ocean water. Because the virus inactivation property was itself heat sensitive, we suspected either inactivation or inhibition by a heat-formed inhibitor. The activity was not inactivated during autoclaving because of the formation of some inhibitor. The addition of equal parts of autoclaved, filtered ocean water to filtered ocean water resulted in a Po-2 inactivation similar to the rate and extent of the virus in filter sterilized ocean water.

TABLE 2

Poliovirus-2 Container Interactions[a]

Water Source	Total Radioactivity Recovered		
	Aqueous Fraction		*SDS Wash*
	1.0 hour (cpm)	14 days (cpm)	14 days (cpm)
Deionized water	875 (77.4)[b]	859 (76.0)	228 (20.2)
Artificial seawater	982 (86.9)	1013 (89.6)	98 (8.6)
Atlantic Ocean water	1111 (98.3)	1010 (89.4)	41 (3.6)
Atlantic Ocean (autoclaved)	1099 (97.3)	1010 (89.4)	52 (4.6)

[a]^{14}C-poliovirus-2 (6.0 × 10³ pfu/cpm) (40 μl) containing 1130 cpm was mixed with 5.0 ml of each respective 0.45 μ filtered water source in sterile Corning 50.0 ml of each respective 0.45 μ filtered water source in sterile Corning 50.0 ml screw capped conical polypropylene tubes and incubated for the indicated times at 17°C. Following incubation for 1.0 hour or 14 days, duplicate 1.0 ml samples were counted in PCS (Amersham Inc.) using the automatic quench correction mode of a Beckman liquid scintillation spectrometer. After 14 days the remainder of the tube contents was discarded, the tube rinsed with 0.01 M Tris-HCl, pH 9.0 containing 9.1% SDS (1.0 ml), and the wash assayed for radioactivity.

[b]Numbers in parenthesis refer to the percent of the cpm recovered relative to the total radioactivity added.

Hydrolytic polypeptide cleavages by activities present in the water may be responsible for virus inactivations. We used an assay for proteolysis which measured the change in pattern and motility of a ^{125}I labeled, highly purified bovine serum albumin on polyacrylamide gels in the presence of SDS.

The incubation of filtered ocean water with ^{125}I-BSA for 25 days at $17°$C resulted in the hydrolysis of nearly half of the total protein (49%) (Figure 2A). Most of the hydrolysis products were found as discrete entities. The major breakdown products were found at apparent mol wts 62,000, 55,000, 38,000, 29,000, 15,000, and about 10,000. A control in which labeled BSA was incubated 25 days in the absence of added ocean water demonstrated that the labeled BSA did not undergo extensive self-hydrolysis or radiation induced breakdown (Figure 2B). Only 6.7% of the total amount of radioactivity was found in regions other than that for BSA. Of this 6.7% the major bands were at the gel top and at about mol wt 62,000. Incubation of the ^{125}I-BSA in autoclaved, filter sterilized ocean water resulted in a pattern unlike that for unautoclaved ocean water. The amount of label in the major component (91.2%) was similar to the incubated control (93.3%), (Figure 2C). These data support the hypothesis of the presence of hydrolytic activities, possibly enzymatic in nature, in ocean water.

Since enzyme mediated proteolytic activities are generally substrate specific, the ideal substrate for the study of poliovirus inactivation necessarily is a highly purified, radiolabeled poliovirus. Accordingly, a stock of ^{14}C-labeled Po-2 was used in studies of proteolytic
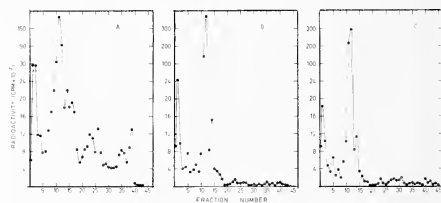

FIG. 2 — Sodium dodecyl sulfate polyacrylamide gel electrophoresis of ^{125}I-BSA. BSA, fraction V, freshly labeled with ^{125}I according to the procedure of Hunter (1967) and with specific radioactivity of 3.9 × 10⁵ cpm/ μg was incubated at 17°C for 25 days in total darkness in a reaction mixture containing 0.38 μg ^{125}I-BSA and either 0.45 μ filtered Atlantic Ocean water (80 μl) filtered deionized water (40 μl), or autoclaved, filtered Atlantic Ocean water (80 μl). After incubation, a sample of each mixture (40 μl) was mixed with 10 μl of a 5-fold concentrated sample denaturation mixture (0.31 M Tris-HCl pH 6.8; 10% w/v SDS; 37.5% v/v glycerol; and 25% v/v 2-mercaptoethanol) heated to 100°C for 1 min, cooled, and injected into the sample wells of a 10% polyacrylamide slab gel. Electrophoresis was for 3.0 hours at 20 ma. The gel was stained with coomassie brilliant blue to visualize marker proteins then cut into 2.0 mm sections. Each section was analyzed for radioactivity by liquid scintillation spectrometry.

Panel A. ^{125}I-BSA incubated in filtered ocean water. *Panel B.* ^{125}I-BSA in filtered deionized water; *Panel C.* ^{125}I-BSA in autoclaved, filtered ocean water.
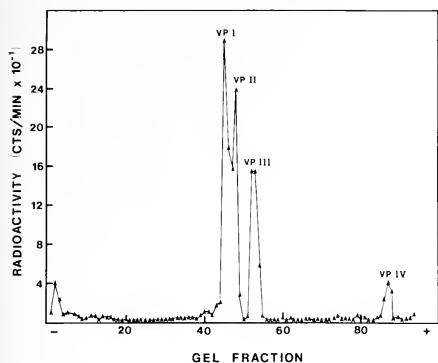
FIG. 3—Sodium dodecyl sulfate polyacrylamide gel electrophoresis of poliovirus-2. ^{14}C-labeled and purified poliovirus-2 (6 × 10^3 pfu/cpm), 2.1 × 10^3 cpm, was heat denatured and applied to a sample well of a 10% polyacrylamide slab gel containing 0.1% SDS according to the procedure described by Baum et al. (1972). Electrophoresis was for 3 hours at 20 ma. The gel was stained with Coomassie brilliant blue to visualize marker proteins and sectioned into 1.0 mm pieces using a mechanical fractionator. The pieces were analyzed for radioactive content according to the procedure of Gerard et al. (1972). Recovery of ^{14}C-labeled material was 82%. The molecular weight marker proteins (in adjacent wells) were phosphorylase, bovine serum albumin, aldolase, ribonuclease I, and cytochrome C.

activity. The molecular weights of the four polypeptides (VP1-35,000; VP2-28,000; VP3-23,000; VP4-7,000) and the molar ratio of polypeptides (1.0, 1.0, 1.0, 0.8, respectively) was the same as found by Maizel (1971) (Figure 3). The total amount of label found in other than those of the four Po-2 component polypeptides was about 2%.

Labeled Po-2 was incubated for 32 days at 17°C in total darkness in either autoclaved-filtered deionized water, autoclaved-filtered ocean water, filtered ocean water, or without further dilution. SDS polyacrylamide gel analysis of the virus after incubation in the filtered ocean water revealed that nearly all of the radioactivity was in molecular species smaller than VP1, VP2, or VP3 (Figure 4B). Most of the ^{14}C-labeled material was found in material near VP4 or at the phenol red front in the gel. About 74% of the radioactivity migrated with the low mol wt components. A small amount of protein degradation was detected in autoclaved-filtered ocean water (Figure 4C). In this water there was an increased amount of material near the region of VP4. The molar ratio of the four peaks of radioactivity at the indicated mol wts for VP1, VP2, VP3 and VP4 was 1.0:1.0:0.9:2.3, respectively. Thus, it is not likely that all of the material found in the region of VP4 was virus-specific VP4. Protein degradation was not evident following incubation of Po-2 in autoclaved-filtered deionized water and the molar ratio of polypeptides was 1.0:1.0:0.9:1.0, respectively, (Figure 4D). To insure that the purified virus did not contain activities responsible for its own proteolysis, labeled Po-2 was incubated for 32 days at 17°C in the

absence of added water (Figure 4A). Little degradation was apparent (molar ratio of polypeptides 1.0:1.0:0.9:0.9) in comparison to Figure 3 indicating that the purified virus was free of significant amounts of active enzymes with any Po-2 polypeptide substrate specificities.

To insure that the test waters were and remained sterile throughout the ^{14}C-Po-2 incubation experiments, samples of each water tested for proteolytic activity were plated at the beginning and after 32d onto trypticase soy agar, seawater agar, and blood agar plates. The plates were incubated at either 15°C or 37°C for a total of 5 days with daily observations. None of the plates showed colony development or were otherwise positive for microorganisms.

Because the rate of inactivation of Po-2 in filtered ocean water was slow, potentially enzyme mediated, and thus difficultly studied, we began to search for methods for isolation and concentration of the activity. Evaporation and perevaporation methods at reduced
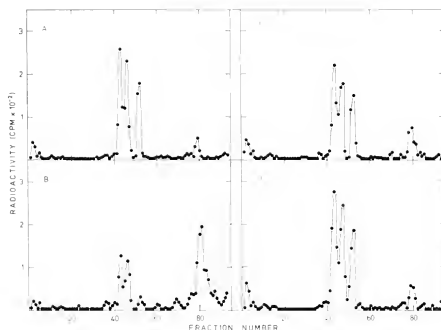

FIG. 4—Sodium dodecyl sulfate polyacrylamide gel electrophoresis of ^{14}C-poliovirus-2. ^{14}C-poliovirus-2 (3.9 × 10^3 cpm/pfu) purified as described in *Materials and Methods* was incubated in reaction mixtures containing 1.2 × 10^7 pfu (3.2 × 10^3 cpm, 0.3 ml) and 5.0 ml of either 0.45 μ filtered ocean water, *panel B;* autoclaved-0.45 μ filtered ocean water, *panel C;* or autoclaved-0.45 μ filtered deionized water, *panel D.* The electrophoretic pattern of ^{14}C-poliovirus-2 incubated without dilution into water is presented in *panel A.* Incubation was for 32 days at 17°C in darkness in sealed tubes. Following incubation, 4.0 ml samples of each mixture were mixed with 10% trichloroacetic acid and 40 μg of carrier BSA added. The mixtures were incubated for 1 hr on ice, then centrifuged at 20,000 rpm in a Beckman JA-21 rotor for 30 min at 4°C. The insoluble material was washed in 2.0 ml volumes of cold acetone and ether followed by collection by centrifugation. The acetone-ether washed pellet was dissolved in 80 μl of the SDS polyacrylamide gel electrophoresis sample buffer (0.062 M Tris-HCl, pH 6.8, 2% w/v SDS, 7.5% v/v glycerol, and 5% v/v 2-mercaptoethanol). The radioactive samples together with molecular weight marker protein were heated to 100°C for 1 min then applied to a 10% polyacrylamide gel containing 0.1% SDS. Electrophoresis was performed as described in Figure 3. Following electrophoresis, the lanes containing radioactivity were sectioned into 1.0 mm pieces and analyzed for radioactivity (Gerard et al. 1972). Recoveries following electrophoresis were as follows: Panel A, 52.5%; Panel B, 78.4%; Panel C, 72.2; Panel D, 85.3%.

temperatures resulted in total loss of the activity. Salting out procedures were found ineffective. The activity was, however, retained but not concentrated after dialysis of filtered ocean water in 12,000 molecular weight cutoff dialysis membrane versus autoclaved, filtered ocean water. Thin channel ultrafiltration at 4°C provided a means for an effective concentration. An 80-fold concentration resulted in a 22-fold increase in rate of inactivation. The inactivation curve was less biphasic in nature (Figure 5). The concentrated activity was found to be heat sensitive, nondialyzable, and inactivated when adjusted to pH 3.2 and/or 11.0 for 30 min followed by return to pH 8.4. The presence of proteins in this concentrated material has been confirmed by polyacrylamide gel electrophoresis in the presence of SDS. In preliminary studies we have observed approximately 7 to 9 distinct, Coomassie brilliant blue R stainable bands on SDS gels. Current studies are directed at the identification and characterization of hydrolytic activities among these proteins.
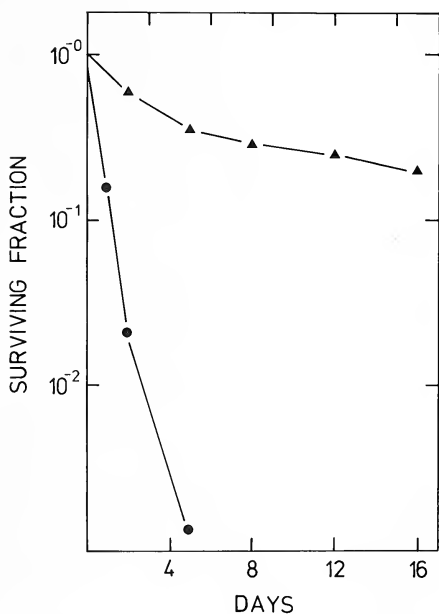

FIG.5 Inactivation kinetics of poliovirus-2 following concentration. A 2 L sample of 0.45 μ filter sterilized ocean water was passed through a sterilized Amicon thin channel ultrafiltration apparatus containing a PM-10 membrane at the rate of 2 ml cm² min at 5°C. The concentrate (25 ml) and filter sterilized ocean water were inoculated with Po-2 at 4.0 × 10⁴ pfu ml under the conditions in Figure 1. Samples were taken at the indicated times for virus assay. ▲ — ▲, filtered ocean water; ● — ●, ultrafiltration concentrate.

Discussion

The important question to which this report addresses is that of the fate of viruses in the natural aqueous environment. The focus has been on the soluble components in ocean water with the capacity to cause virus inactivation.

The inactivation of Po-2 in natural, filter-sterilized ocean surface water was found to be biphasic with a rapid phase ($T_{99.9\%}$ = 30 d) accounting for the loss of about 80% of the virus infectivity. The much slower secondary inactivation rate ($T_{99.9\%}$ = 400 d) was likely due to the presence of aggregates in the stock of purified Po-2, an hypothesis supported by the observation that about 20% of the infectivity of the highly purified virus migrated more rapidly than for individual Po-2 particles in rate-zonal gradients. This rapid component contained the same polypeptide pattern indicative of intact Po-2, and all but 1% of the label was in the four viral polypeptides. Both pH and salinity were found to affect the rate of Po-2 inactivation. Increasing the salinity and hydrogen ion concentrations increased the initial rates of inactivation and reduced the biphasic nature of the curves. This latter process is likely due to disaggregation of virus aggregates at higher pH and salinity rendering a monomeric virus more sensitive to inactivating events surrounding it.

The resolution of virus polypeptides or BSA by SDS polyacrylamide gel electrophoresis following long incubations in filter sterilized ocean water suggested proteolytic activity (Figures 2 and 4). The activity was destroyed by autoclaving and was neither dialyzable nor present in autoclaved-filtered deionized or ocean water. In control long term incubation studies proteolytic activity was not detected in the preparations of either ¹²⁵I-BSA or ¹⁴C-Po-2. Mixing experiments demonstrated that an inhibitor of virus inactivation did not form during autoclaving. Thin channel ultrafiltration resulted in concentration of the activity thus providing a process more amenable to laboratory experimentation. The point must, however, be made that the concentrated activity may be a mixture of activities which will require considerable dissection and study. Furthermore, the concentrated activity may be unrelated to that studied in the unconcentrated samples.

The phenomenon of natural virucidal activity in water was first reported by Plissier and Therre (1961). These authors reported that the inactivation of poliovirus type 1 (Mahoney) in seawater depended upon the initial virus concentration seeded and was such that at 17°C, seedings of 10⁴·⁸ TCID₅₀ resulted in active virus after 150 d. In studies of the infectivity of poliovirus type 1 in seawater obtained from the Gulf of Mexico, Akin et al. (1976) reported loss of viral activity in raw, filter-sterilized, and autoclaved water. Virus infectivity was also lost in water composed of dilutions of artificial seawater and deionized water, but not as rapidly in deionized water alone. Virus inactivation was more rapid in estuarine water than in natural freshwater. Control experiments demonstrated the absence of con-

tainer interactions and viral aggregation. Studies supporting the virucidal activity of seawater have been reported by Lycke et al. (1965) and Magnusson et al. (1966) who demonstrated that waters from the Baltic and North Seas, respectively, possessed virucidal activity for six common enteric viruses. The rate of inactivation ($T_{90\%}$ = 6-9 d) was decreased by boiling. In contrast, freshwater samples were devoid of virus inactivating activity above that predicted by thermal decay. Water samples from the Mediterranean Sea (Matossian and Garabedian, 1967; Shuval et al., (1971) and the North Atlantic Ocean (McLean and Brown, 1968) have also been shown to possess virus-inactivating capacity. In these studies a decrease of 90% (90%) required about 2 days and filter sterilization removed this rapid inactivation capacity. In each of the preceeding reports and as presented in the review by Katzenelson (1978) there is consensus that marine antiviral activity exists in seawater provided that a 3-log inactivation of poliovirus occurs within a 7 day period at 15°C. Our studies ($T_{90.0\%}$ = 20 d, at 17°C) suggest that such an active marine antiviral activity was either not present in our collected samples or was removed by filter sterilization.

There has been no report of a successful isolation of any specific and active marine virus inactivating factor. A nondialyzable factor which was apparently responsible for inactivation of polivirus by Rio Grande river water was reported by O'Brian and Newman (1977). The active principal was found to be sensitive to heat and was considered proteinaceous in nature but was not isolated.

Microbial degradation of particulate organic matter i.e. protein, carbohydrate, hemicellulose, is an essential component of carbon recycling in natural waters. In waters of moderate depths as much as 75 to 99% of particulate organic matter producedc autotrophically in the epilimnion was degraded before reaching the sediment (Ohle, 1962). In another study some 88% was decomposed before leaving the epilimnion (Wetzel et al., 1972).

Proteolysis is important in the solubilization of protein in natural waters as it may affect the rate of sedimentation and, thus, the degree of anaerobiosis in the hypolimnion and at the sediment surface. Microbial proteases are frequently produced by members of the genera *Pseudomonas, Vibrio,* and *Acinetobacter,* and both production and excretion are known to be under the control of complex regulatory phenomenon. As yet, there has been no conclusive proof of the action of proteolytic enzymes from these microorganisms on either naturally occurring soluble or particulate protein or viruses in environmental situations.

Using an assay which measured the rate of release of soluble azure dye derivative from hyde powder, Little et al. (1979) determined that natural unfiltered waters from lake Chaplain were proteolytic, the activity most closely associated with waters containing *Pseudomonas* and *Flavobacterium* species. They did not detect activity in water sterilized by microfiltration. Rinderknecht et al. (1968) quantified the dye-solubilization

assay for several proteolytic enzymes. The assay was useful for the detection of proteolytic activity in the range of 0.01 μg/ml of trypsin and was proportional to enzyme concentration at levels of 0.1 μg/ml and above. Since many proteinases require specific substrates and cofactors and since the soluble proteolytic activity in natural waters can be expected to be very low, it is likely that some proteolytic activities would remain undetected usxing of dye-solubilization assay.

Laboratory studies have suggested that enterovirus titer reduction is a consequence of microbial growth or degradation. Magnusson et al. (1967) reported a relationship between virus inactivation capacity of seawater and mixed cultures of marine bacteria. Gunderson et al. (1967) isolated a pure *Vibrio* culture which possessed virus inactivation capacity. Ramanathan et al. (1968) demonstrated antiviral activity in extracts of *Propionibacterium freudenreichii.* The name "propionin" was applied to bacterial extracts which were reported to be effective against vaccinia and lymphocytic choriomeningitis virus. Kelley et al. (1961) identified and prepared pure cultures of *Flavobacterium, Klebsiella,* and coliform strains from wastewater sludge that were capable of rapid poliovirus inactivation. Sobsey and Copper (1971) reported that a mixed culture of *Scenedesmus quadricauda* and an unspecified bacteria reduced poliovirus infectivity by three logs at 25°C in three days.

Cliver and Herrmann (1972) demonstrated that some enteroviruses are susceptible to specific hydrolytic or proteolytic enzymes. Coxsackievirus type A-9 and also the poliovirus strains, 1, 2, and 3 were found susceptible to lysozyme and neutral protease from *Gallus gallus* and *Bacillus subtilis,* respectively. Both *Bacillus subtilus* and *Pseudomonas aeruginosa* showed marked ability to inactivate Coxsackievirus type A-9 when added to the virus in sterile deionized water samples. Experiments with amino acid labeled virus preparations indicated that at least some portion of the virus particle was degraded and the release protein could be used as a substrate for bacterial growth. Cliver attributed most of the inactivation to processes involving enzymic proteolytic action, but further reported that a material with apparent molecular weight of 500 or less was involved.

The cumulative data suggests, at least in laboratory experiments, that biological mechanisms promulgated by microorganisms or other organisms may play an essential role in natural processes of virus inactivation in water. In this report we have measured the rates of inactivation of Po-2 in waters obtained from the Tidewater area of Virginia and have detected and concentrated a heat sensitive, nondialyzable proteolytic activity from marine surface water that appears to be responsible for the hydrolysis of Po-2 capsid proteins.

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Vascular Flora of the Jones and Mill Creek Watershed, Powhatan County, Virginia*

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Abstract—This floristic study in the southeastern Virginia Pied-
mont began in February, 1976 and continued until June, 1977. The
study area encompasses approximately 25 square miles in north-
eastern Powhatan County. The boundaries of the area include the
James River and the natural watershed divides of Jones and Mill
Creek. Some of the more interesting and unusual habitats in the
area, to which special attention was paid in this study, include the
rocky bluffs and steep ravines along the James River, the granitic
outcrops which occur throughout the area, and two extensive
swamps, each adjoining an old mill pond. While interesting and
sometimes unusual species were found in these habitats, the charac-
teristic Piedmont flora was also observed and collected throughout
the study area.

A total of 814 species of vascular plants have been collected and
identified, the majority of which are new Powhatan County records.
Some of the distributional records established include *Eriochloa
gracilis*, a state record, and *Crotalaria mucronata* and *Iresine rhizo-
matosa*, both new Piedmont records.

The geology of the study area is discussed, and a phytogeogra-
phical analysis made of the flora of the Jones and Mill Creek
Watershed. The geographical affinities of the flora are similar to
those of the state of Virginia as a whole, being most closely related to
the flora of temperate eastern and midwestern North America, and
with smaller circumboreal, eastern Asiatic, tropical, and cosmopoli-
tan links.

Introduction

The Jones and Mill Creek Watershed is located in
the Fine Creek Mills area of northeast Powhatan
County, in the southeast section of the Virginia Pied-
mont. The study area, encompassing approximately 25
square miles, is delimited by major watercourses and
by highways that follow natural watershed divides:
The James River on the north, Fine Creek and Virginia
Route 628 on the west, Virginia Route 671 on the
south, and Norwood Creek and Virginia Routes 613
and 614 on the east. The study area includes Jones
Creek east of Virginia Route 628, and its tributary Mill
Creek. Also included is the continuation of Jones
Creek below Woodberry Pond, Norwood Creek, and
Fine Creek north of Virginia Route 711. Elevation in
the study area ranges from 150 ft. on the James River
to 450 ft. in the southern half of the area.

The Piedmont location of the study area was chosen
with the deficiencies in the overall floristic knowledge
of the state in mind. In the past the Piedmont has been
considered by botanists to be floristically depauperate
and therefore the least attractive of the physiographic
provinces in Virginia (Harvill 1969a), and thus its flora
is the least known. There are also many mountain-
coastal plain disjuncts in Virginia (Harvill 1965, 1972,
1975), and only as more work is done in the Piedmont
will it be known if these disjuncts are real, or merely

collecting artifacts. Besides small collections made by
Johnson (1970, 1972a), only scattered collecting has
been done, and few published records exist for Powha-
tan County. The Fine Creek Mills area of Powhatan
County has three very interesting habitats: steep rocky
bluffs along the James River, two old mill ponds and
their associated swamps, and a series of granitic rock
outcrops which occur throughout the study area.
Thus, the Jones and Mill Creek Watershed seemed an
ideal location for a floristic study. In addition to the
study of the flora of the Jones and Mill Creek
Watershed, the geographical affinities of the flora are
analyzed.

Methods

Collection of specimens of the vascular flora of the
Jones and Mill Creek Watershed began in February
1976, and continued until June 1977. In order to be as
thorough as possible in the collection of the flora, sites
representative of each habitat type present in the area
were visited and collected at on each expedition. Spec-
imens were collected in triplicate and numbered with
the first author's collecting number. Note was made of
the location, habitat, and abundance of each plant.
Abundance was classified as rare (one to few individu-
als seen), uncommon (several individuals seen), occa-
sional (small colonies seen at more than one site),
common (colonies seen at several sites), or abundant
(colonies seen throughout the area). After pressing and
identification of the specimens, the voucher set was
deposited in the herbarium of the College of William
and Mary (WILLI). Additional sets of specimens are
deposited at the University of North Carolina at
Chapel Hill (NCU), Tulane University (NO), and
Southern Methodist University (SMU).

The following manuals were used for identification

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of the specimens: Radford, Ahles, and Bell (1968), Gleason and Cronquist (1963), Gleason (1952), Fernald (1950), Bailey (1949), Hitchcock (1935), Rehder (1967), and Gould (1975).

Nomenclature follows Radford, Ahles, and Bell (1968), except where noted, and in that case follows Hitchcock (1935).

Determination of state, Piedmont, southern Piedmont (south of the James River), and county distributional records was made by consulting the published records of Allard and Leonard (1943, 1944, 1952, 1962), Boule (1979), Bradley (1972), Crow (1978), Diggs and Hall (1981), Duncan (1967), Harvill (1967, 1969a, 1973a, 1977), Hathaway and Ramsey (1973), Hill (1980), Johnson (1970, 1971a, 1971b, 1972a, 1972b, 1974a, 1974b, 1974c), Johnson and Joosten (1977), Kral and Bostick (1969), Lewis (1958), Massey (1961), Mazzeo (1972), Nessler (1976), Parker (1977), Ramsey (1967), Ramsey, et al. (1969), Roane (1975), Roe (1977), Shinners (1962), Smith (1976), Thacker, et al. (1968), Uttal and Mitchell (1970), and Woodson, et al. (1977).

The geographical range of the plants of the Jones and Mill Creek Watershed was determined by consulting Fernald (1950), Gleason (1952), Gleason and Cronquist (1963), Small (1933), Hitchcock (1935), Harvill (1973b), Li (1952), and Hultén (1937, 1958). The phytogeographical range patterns used were adapted from Harvill (1973b).

The annotated checklist of the flora of the Jones and Mill Creek Watershed includes each species' abundance, range, habitat, and collecting number(s). Distributional records are indicated in the checklist. In addition, the taxa are enumerated according to their geographical range and habitat, and the significant phytogeographical affinities of the flora are discussed.

Geology

Powhatan County lies within the Piedmont physiographic province, the non-mountainous portion of the "older Appalachians" (Fenneman 1938). The Piedmont plateau surface, which has a gentle southeast slope, is the result of the degradation of its crystalline rocks, both sedimentary and igneous, which have been greatly altered by metamorphism (Watson 1907). The topography of Powhatan County is similar to the rest of the Piedmont, a rolling surface of gentle slopes into which streams have sunk their channels.

The study area lies within the gneisses and schists of the eastern Virginia Piedmont. There are three important formations along the James River in Powhatan County. The State Farm Gneiss is a north-northeast trending doubly plunging antiform which extends south of the James River throughout the study area. The Fine Creek Mills Granite occupies the core of this antiform. The Fine Creek Mills Granite outcrops at Fine Creek Mills and other places in the study area due to severe erosion of the antiform. Above the State Farm Gneiss and flanking the antiform is the Sabot Amphibolite. The James River floodplain in the study area is covered with a Quaternary alluvium of sand, silt, and gravel. The bluffs along the river are topped by beds of Tertiary gravel. (Poland and Glover 1976).

Also important in the geology of the area is the Richmond Basin, a Mesozoic basin which lies in several counties, including the eastern portion of Powhatan. The rocks bordering on and underlying the basin are the typical Piedmont granites and gneisses. The basin itself is a series of sandstone, shale and coal beds. The Richmond Basin was the first source of coal in the United States and was mined for many years. (Watson 1907).

The Piedmont province is not noted for its soil fertility, and erosion has long been a problem. The alluvial plains offer the best soils. (Fenneman 1938). The soil type in the study area is the common one all over the Piedmont, red and yellow podzolic. It has a thin dark-colored organic layer over a yellow-grey or grey-brown leached layer over a darker clayey layer of deposition which grades into the deeply weathered parent material. (Hunt 1972). There are two soil associations that are important in the study area. In the lowland along the river occurs the *Altavista-Wicham-Chewacla* association, a moderately drained soil with a yellowish-brown to yellowish-red friable clay loam to gray silty loam subsoil. In the upland of the area occurs the *Cecil-Masada* association, a deep well drained soil with a red to yellowish-red firm clayey subsoil. (United States Department of Agriculture Soil Conservation Service 1972).

Vegetational Patterns

The Fine Creek Mills area of Powhatan County has, in addition to the typical Piedmont topography and vegetation, three unusually interesting habitats, to which special attention has been paid in this study: the steep rocky bluffs and ravines on the James River, the series of granitic rock outcrops which occur throughout the area, and the two old mill ponds and their associated swamps. Many of the unusual and floristically interesting species were found in these habitats, but the characteristic Piedmont flora was also observed and collected throughout the entire study area.

The James River valley is quite a diverse portion of the study area, with its rocky bluffs, rich ravines, and flat floodplains, both open and wooded. *Polypodium virginianum, Carex blanda, C. platyphylla, Iris cristata, Erythronium americanum, Sanguinaria canadensis,* and *Rhododendron nudiflorum* are characteristic species found on the bluffs of the James. An association of *Dicentra canadensis, Asarum canadense, Adiantum pedatum,* and a large colony of *Jeffersonia diphylla* is growing in one particularly rich and steep ravine. In another ravine through which a stream flows into the James grows *Carex albursina, Habenaria clavellata, Orchis spectabilis, Liparis lilifolia, Melanthium virginicum, Uvularia pudica, Aristolochia serpentaria,* and *Matelea suberosa.* Species commonly growing along the floodplain of the James include *Impatiens capensis, Ellisia nyctelea, Nemo-*

phila microcalyx, Humulus japonicus, Conium macul-atum, Erysimum cheiranthoides, and several *Solidago* spp. Other species, such as *Impatiens pallida, Hydrophyllum canadense, Arisaema dracontium, Sicyos angulatus, Erigeron philadelphicus, Agstache nepetoides,* and *Iresine rhizomatosa* are also found along the floodplain, although much less frequently. Interesting grasses recorded along the floodplain include *Arthraxon hispidus, Eragrostis hypnoides, Microstegium vimineum,* and *Paspalum fluitans.*

The upland woods in the study area are of several types. In the deciduous woods in sites such as the bluffs the common species include *Quercus alba, Q. falcata, Q. prinus, Carya ovalis, C. tomentosa, Cercis canadensis, Ostrya virginica, Carpinus carolinianina,* and *Chionanthus virginicus.* Stands of mixed pine-deciduous woods are common in the study area. The typical tree species seen in these woods are *Pinus virginia, P. echinata, Juniperus virginiana, Quercus alba, Carya tomentosa, Cornus florida,* and *Ilex opaca.* There are also several pure pine stands of *Pinus virginiana* and *P. echinata* in the area. Shrubs such as *Gaylussacia baccata,* and *Vaccinium stamineum* are common in the pine woods, as are herbs such as *Cypripedium acaule, Chimaphila maculata,* and *C. umbellata.*

Low woods occur on the floodplain of the James as well as surrounding the streams, lakes, and ponds in the area. Here *Acer rubrum, A. negundo, A. saccharinum, Liquidambar styraciflua, Nyssa sylvatica, Betula nigra, Salix nigra,* and *Carpinus caroliniana* are found, as well as *Platanus occidentalis, Fraxinus pennsylvanica, Liriodendron tulipifera, Ulmus americana, Carya cordiformis,* and *Cornus florida.* Shrubs found around wet areas include *Alnus serrulata, Cephalanthus occidentalis, Itea virginica,* and *Leucothoe racemosa.*

Two of the old mill ponds in the area, Woodberry Pond on Jones Creek and Mill Pond on Mill Creek, have extensive swamps behind them, and many interesting taxa occur in these waterways. *Potamogeton diversifolius, P. epihydrus, Spirodela polyrrhiza, Egeria densa, Heteranthera renifornis, Utricularia biflora, Callitriche heterophylla, Nuphar luteum,* and *Nymphaea odorata* are some of the aquatics found. Common emergents include *Juncus* spp., *Carex* spp., *Cyperus* spp., *Dulichium arundinaceum, Alisma subcordatum, Sagittaria latifolia, Sparganium americanum, Peltandra virginica,* and *Chelone glabra.* Herbs found in low woods surrounding the waters include *Lycopodium lucidulum, Selaginella apoda, Symplocarpus foetidus, Dryopteris cristata, Ophioglossum vulgatum, Chrysosplenium americanum, Euphorbia obtusata, Aconitum uncinatum, Habenaria lacera, H. flava,* and *Apios americana.* Common bottomland grasses are *Eragrostis capillaris, Glyceria striata, Leersia virginica, Panicum capillare, P. stipitatum, Poa sylvestris,* and *P. trivialis.*

Granitic rock outcrops occur throughout the study area, with two very extensive ones at Fine Creek Mills and Flat Rock. These outcrops were surveyed by Berg in his study of the vegetation and succession on Pied-mont granitic outcrops in Virginia (Berg 1974). While several southeastern outcrop endemics such as *Sedum pusillum, Portulaca smallii, Cyperus granitophyllus,* and *Juncus georgianus* are not found on the outcrops in Powhatan, other characteristic species are found. Typical dicotyledons growing on the outcrops are *Opuntia compressa, Arenaria groenlandica* var. *glabra, Talinum teretifolium, Crotonopsis elliptica, Portulaca oleracea, Phacelia dubia, Linaria canadensis, Krigia virginica, Sherardia arvensis,* and *Hypericum gentianoides.* Outcrop pteridophytes and monocotyledons include *Selaginella rupestris, Cyperus aristatus, Eleocharis engelmannii, E. obtusa, Fimbristylis autumnalis, Bulbostylis capillaris, Xyris torta, Agrostis elliotiana,* and *Panicum laxiflorum.*

Successional areas around Fine Creek Mills include mostly abandoned fields, and these are quite common as farms are sold to build subdivisions. Interesting species found in abandoned fields are *Kickxia elatine, Abutilon theophrastii, Thalaspi arvense, Isanthus brachiatus,* and *Triosteum perfoliatum.* More commontly found are *Asclepias* spp., *Solidago* spp., *Erigeron* spp., *Eupatorium* spp., *Liatris squarrosa, Spiranthes gracilis, S. grayi, Papaver dubium,* and *Centaurea cyanus.* Grasses found in old fields include *Eragrostis spectabilis, Sorghum halepense, Setaria* spp., and *Andropogon* spp.

At the most recently disturbed areas such as roadsides and building sites are found many weedy species. The most common grasses are *Panicum* spp., *Paspalum* spp., *Aristida* spp., *Andropogon* spp., *Aira caryophyllea, A. elegans, Eragrostis curvula, Erianthus contortus, Miscanthus sinensis,* and a grass newly reported for Virginia, *Eriochloa gracilis.* Other herbs found in disturbed areas include *Holosteum umbellatum, Aster* spp., *Coreopsis lanceolata, C. verticillata, Daucus carota, Amaranthus* spp., *Baptisia tinctoria, Lespedeza* spp., *Desmodium* spp., *Trifolium* spp., and *Viola* spp.

Phytogeography

The physiographic diversity of Virginia and its escape from past glaciation, combined with a relatively long and favorable growing season, has resulted in a rich flora of diverse affinities. Relationships with the floras of subtropical, tropical and boreal North America occur, as well as affinities to western North America, eastern Asia, and western Europe (Harvill et al. 1977).

The ranges of the species of the Jones and Mill Creek Watershed fall into seven categories (modified from Harvill 1973b):

1. Circumboreal, totally circumboreal or interrupted.
2. Native to North America and Eastern Asia.
3. Native to North American and extending to both the Atlantic and Pacific coasts.
4. Native to temperate North America and the West Indies, Mexico, or Central or South America.
5. Native to eastern North America. The majority of these species range west beyond the Mississippi

River, but do not extend to the Pacific coast.

6. Widespread species which extend south of the United States and to the Old World.

7. Introduced species, now naturalized.

The distributions given are for the species, and include any subspecific taxa. Distributions were determined by consulting Fernald (1950), Gleason (1952), Gleason and Cronquist (1963), Small (1933), Hitchcock (1935), Harvill (1973b), Li (1952), and Hultén (1937, 1958). Because no single author is comprehensive in range descriptions, especially in the case of ranges extending outside the United States, no one source is taken as absolute. The range listed for each species is the composite of all distributions as listed by each author, and is thus subject to some error, as workers' concepts of a particular species may vary.

The species are further divided into groups according to the habitat where they occured most commonly. Since the study was basically floristic, no attempt was made to exhaustively sample each species' ecological amplitude. Dividing the habitats into more precise units did not result in any meaningful patterns, so rather broad, and often heterogenous categories were used. The habitat categories are:

1. Forest; includes the dryer upland and more mesic to wet lowland woods.

2. Disturbed sites; includes a variety of sites that experience continued or interrupted physical disturbances, such as moving, grazing, periodic inundation, etc.

3. Aquatic; includes those species growing in water.

4. Rock outcrop; includes species growing on the exposed granitic outcrops which occur throughout the area.

5. Not classified; includes species that occur commonly in several habitats and are not characteristic to any one.

The general phytogeographical affinities of the flora of the Jones and Mill Creek Watershed are shown in Table 1. In general, the affinities are not unlike those of the state of Virginia as a whole, although the relative proportions may differ (Harvill et al. 1977). The region and its flora are clearly continuous with the flora of eastern North America. The flora of the Jones and Mill Creek Watershed encompasses no endemics, and only 25% of the native species extend beyond the temperate eastern-midwestern regions of North America. The southern element comprises approximately 11% of the total flora; and while these species occur in all the habitats, and are most numerous in the disturbed sites, they are most important in the aquatic and rock outcrop floras.

The circumboreal species are a minor element in the flora, which given the Piedmont location of the study area, is not surprising. These species are most common in the forests, and seven of the 20 species involved are pteridophytes, including *Botrychium virginianum, Dryopteris cristata, Ophioglossum vulgatum,* and *Polypodium virginianum.* Both the pan-North American and widespread elements are relatively small, and neither show any distinct correlation with any particu-

TABLE 1

Phytogeographical relations of the Jones and Mill Creek Watershed flora. See text for discussion of ranges and habitats. For each habitat the number of species in each range category is given in the first row, the percentage of the total flora of each range-habitat category is in the second row, and the percentage of the species within the habitat for each distribution range is given in the third row. The total number of species in each habitat and their percentage of the flora are given in the far right column. The total number of species for each range category and their percentage of the flora are given in the bottom two rows.

HABITAT	Range 1 Circumboreal	Range 2 N. America & E. Asia	Range 3 Pan-N. America	Range 4 So. of U.S.	Range 5 E. N. America	Range 6 Widespread	Range 7 Introduced	Total
Forest								
number	12	7	10	19	282	3	13	346
%flora	1.5	0.9	1.2	2.3	34.7	0.4	1.6	42.6
%habitat	3.5	2.0	2.9	5.5	81.5	0.9	3.7	
Disturbed								
number	6	1	16	45	165	4	152	389
%flora	0.7	0.1	2.0	5.5	20.3	0.5	18.7	47.9
%habitat	1.5	0.3	4.1	11.6	42.4	1.0	39.1	
Aquatic								
number	1	–	6	13	12	3	1	36
%flora	0.1	–	0.7	1.6	1.5	0.4	0.1	4.4
%habitat	2.8	–	16.7	36.1	33.3	8.3	2.8	–
Rock outcrop								
number	–	–	–	9	17	–	5	31
%flora	–	–	–	1.1	2.1	–	0.6	3.8
%habitat	–	–	–	29.0	54.8	–	16.1	–
Not classified								
number	–	–	–	2	5	–	3	10
%flora	–	–	–	0.2	0.6	–	0.4	1.2
%habitat	–	–	–	20	50	–	30	–
Total								
number	19	8	32	88	481	10	174	812
%flora	2.3	1.0	3.9	10.8	59.2	1.2	21.4	100

lar habitat. The other minor floristic group is the eight species, seven of which occur in the forests, that demonstrate the connection—or at least an ecological similarity—between temperate east Asia and North America. Had analysis been done on the generic level the relationship between the two floras would be more evident (Li 1952). However, *Onoclea sensibilis, Lycopodium obscurum, Symplocarpus foetidus, Monotropa uniflora, Phryma leptostacha, Tovara virginiana, Adiantum pedatum,* and *Carex pensylvanica* do show the east Asian affinity of their distributions. It is not possible to ascertain whether these distributions are due to the fragmentation of a once continuous paleoflora, or to long distance dispersal and the presence of similar habitats.

The extent of human impact on the area is evident, with nearly half of the flora occurring in disturbed sites and approximately 20% of the total flora being introduced. The majority (87%) of the introduced species occur in disturbed sites. Some possible exceptions are *Rumex acetosella, Sedum sarmentosum,* and *Scleran-*

thus anuus which have become established on rock outcrops. However, the outcrop habitat includes micro-environments of low biotic and high abiotic stress (Shure and Ragsdale 1977), which may explain success of the exotics. The establishment of such species as *Ailanthus altissima, Vicia hirusta, Perilla frutescens,* and *Polygonum hydropiper* in the forest may be more a reflection of disturbance in the habitat, than of their ability to invade closed vegetation.

Distribution Records and Annotated Checklist of the Vascular Flora of the Jones and Mill Creek Watershed

A total of 812 species representing 433 genera of 120 families of vascular plants are recorded here for Powhatan County. Six hundred fifty-three of these species have not been reported in the literature as occurring in Powhatan County. Twenty-four of the 653 are new to the Piedmont of Virginia, and 51 of the 653 have not been reported to occur in the Virginia Piedmont south of the James River. One species, *Eriochloa gracilis,* is newly reported for the state of Virginia. Other species of special distributional interest are *Crotalaria mucronata,* previously reported in Virginia only from Gloucester County in the Coastal Plain, and *Iresine rhizomatosa,* previously reported in Virginia from four Coastal Plain counties.

None of the species newly recorded for the Piedmont or southern Piedmont in Virginia in this study are classical mountain-coastal plain disjunct species

(Harvill 1969b, 1972, 1973c, 1979). All new records are either introduced species or species heretofore known only from the mountains, Coastal Plain, and/or the northern Piedmont.

In the checklist nomenclature follows Radford, Ahles, and Bell (1968) unless noted by a cross (+), and in these cases nomenclature follows Hitchcock (1950). Taxa that are county records are preceded by an asterisk (*); taxa that are southern Piedmont records are preceded by a double asterisk (**); taxa that are Piedmont records by a triple asterisk (***); and state records by four asterisks (****). The name of each taxon is then followed by four codes. First, the abundance of each taxon is indicated by the following abbreviations: R = rare; U = uncommon; O = occasional; C = common; A = abundant. The abundance code is then followed by a number indicating the range of each taxon (range patterns are defined in the Phytogeographical analysis). The habitat(s) from which each taxon was collected is then indicated by the following abbreviations: LW = lowland woods; UW = upland woods; RO = rock outcrops; AQ = aquatic; B = bluffs on the James River; FP = James River floodplain; S = successional areas; RD = recently disturbed areas. The last number(s) in each entry is the first author's collecting number(s).

The taxa here recorded include: 570 species of dicotyledons representing 316 genera and 91 families; 210 species of monocotyledons representing 97 genera and 18 families; four species of conifers representing two genera and two families; and 28 species of pteridophytes representing 18 genera and nine families.

Annotated Checklist

PTERIDOPHYTA

ASPIDIACEAE: *Athyrium asplenioides, C, 5, LW; 1003, 1501. *A. thelypterioides, U, 5, B; 1417. *Cystopteris protrusa, R, 5, B; 571. *Dryopteris cristata, C, 1, LW; 679. D. marginalis, O, 5, B; 1409. *D. spinulosa, O, 1, LW; 1465. Onoclea sensibilis, O, 2, RD; 1494. Polystichum acrostichoides, C, 4, LW; 12, 908. *Thelypteris hexagonoptera, O, 5, LW; 1133. T. noveboracensis, O, 5, RD; 1502. T. palustris, O, 6, LW; 1468. Woodsia obtusa, O, 5, RO; 431, 699.

ASPLENIACEAE: Asplenium platyneuron, C, 5, LW; 1083.

BLECHNACEAE: *Woodwardia areolata, C, 5, LW; 911.

LYCOPODIACEAE: Lycopodium flabelliforme, A, 5, LW; 1488, 1599. *L. lucidulum, O, 5, LW; 305, 1075. *L. obscurum, A, 2, LW; 86, 836.

OPHIOGLOSSACEAE: Botrychium dissectum, O, 5, UW; 9. B. virginianum, C, 1, B; 119. *Ophioglossum vulgatum var. pycnostichum, U, 1, LW; 220, 576.

OSMUNDACEAE: *Osmunda cinnamomea, O, 6, LW; 200. O. regalis var. spectabilis, U, 1, LW; 642.

POLYPODIACEAE: *Polypodium virginianum, R, 1, B; 16.

PTERIDACEAE: *Adiantum pedatum, O, 2, B; 1410. Dennstaedtia punctilobula, O, 5, RO; 1637. Pteridium aquilinum, O, 6, UW; 958.

SELAGINELLACEAE: *Selaginella apoda, O, 4, LW; 131. S. rupestris, A, 5, RO; 1517.

CONIFEROPHYTA

CUPRESSACEAE: Juniperus virginiana, C, 5, RO; 428, 1514.

PINACEAE: **Pinus echinata, O, 5, UW; 1565, 1567. *P. taeda, O, 5, RD; 1427. P. virginiana, A, 5, UW; 1423.

ANTHOPHYTA

MONOCOTYLEDONEAE

ALISMATACEAE: Alisma subcordatum, O, 4, AQ; 1060, 1089. *Sagittaria latifolia var. pubescens, A, 4, AQ; 835.

AMARYLLIDACEAE: *Hypoxis hirsuta, U, 5, RD; 328.

ARACEAE: *Arisaema dracontium, O, 5, FP; 795. A. triphyllum, C, 5, LW; 327. Peltandra virginica, C, 5, AQ; 604. Symplocarpus foetidus, A, 2, LW; 83, 327.

COMMELINACEAE: Commelina communis, O, 7, RD; 869, 1400. C. erecta, O, 4, RO; 1097, 1527. C. virginica, O, 5, LW; 1054, 1474. *Tradescantia virginiana, U, 5, RD; 479.

CYPERACEAE: *Bulbostylis capillaris, C, 4, RO, RD; 1120, 1160, 1438. Carex albolutescens, O, 4, AQ; 662, 1096. *C. albursina, U, 5, LW; 272. *C. blanda, O, 5, B, RO; 320, 443. C. caroliniana, O, 5, RO; 695. *C. cephalophora, O, 5, LW; 490, 671. *C. comosa, O, 3, LW; 1145, 1153. C. complanata, O, 5, LW, RD; 326, 380. C. crinita, O, 5, LW; 678. C. debilis, O, 5, LW; 356. *C. frankii, O, 5, RO; 698, 1115. C. gracillima, O, 5, RO; 446. C. grayi, O, 5, FP; 552. C. grisea, C, 5, LW; 381, 532. **C. howei, U, 5, LW; 318. C. intumescens, O, 5, LW; 355. C. laevivaginata, O, 5, LW; 258. *C. leavenworthii, O, 5, LW; 367. C. lupilina, O, 5, LW; 1157. C. lurida, C, 4, LW; 666. *C. muhlenbergii, O, 5, LW; 489. *C. pensylvanica, O, 2, LW; 115, 331. C. physorhyncha, U, 4, LW; 215. *C. platyphylla, C, 5, B; 295. *C. prasina, O, 5, LW; 221, 591. C. rosea, C, 5, LW; 675. *C. spaganioides, O, 5, B; 321. C. squarrosa, U, 5, LW; 1399. **C. swanii, O, 5, RO; 612. *C. tribuloides, O, 5, FP; 569. C. vulpinoidea, O, 3, LW; 988. **Cyperus aristatus, U, 6, S, 1100. *C. erythrorhizos, U, 3, LW; 1481.

*C. ferruginescens, O, 3, FP; 1302. *C. filiculmis, O, 5, RD; 1140, 1250. C. lancastriensis, O, 5, RD; 923a. C. ovularis, O, 5, RD, RO; 919, 1116. *C. polystachyos var. texensis, U, 6, RD; 1244. *C. strigosus, O, 3, LW, RD; 1260, 1363. *Dulichium arundinaceum, O, 3, AQ; 997, 1148. Eleocharis engelmannii, C, 3, AQ; 434. E. obtusa, O, 3, AQ; 1091. *E. tenuis, O, 5, AQ; 612. *Fimbristylis autumnalis, O, 4, RO; 1095, 1352. *Rhynchospora capitellata, O, 3, AQ; 1088, 1252. *Scirpus cyperinus, C, 5, AQ; 980. *S. polyphyllus, C, 5, AQ; 834, 1207. *S. purshianus, O, 5, AQ; 1614. S. validus, U, 3, AQ; 742. *Scleria oligantha, U, 4, LW; 788.

DIOSCOREACEAE: Dioscorea villosa, O, 5, LW; 500.

HYDROCHARITACEAE: Egeria densa, A, 7, AQ; 139, 723.

IRIDACEAE: *Iris cristata, O, 5, B; 222. **I. psuedacorus, O, 7, LW; 363. Sisyrinchium angustifolium, O, 5, RO; 439.

JUNCACEAE: Juncus acuminatus, O, 4, AQ; 616. *J. bufonius, O, 6, AQ; 631. J. coriaceus, O, 5, AQ; 1128. J. effusus, C, 6, LW, RD; 934, 989. J. marginatus, O, 5, AQ; 1249a. *J. tenuis, O, 3, FP, RD; 894, 1019. *Luzula bulbosa, O, 5, RD; 144. *L. echinata, O, 5, LW; 230. *L. multiflora, U, 1, B; 17.

LEMNACEAE: *Lemna perpusilla, U, 4, AQ; 1536. *Spirodela polyrrhiza, O, 4, AQ; 639.

LILACEAE: *Allium cepa, U, 7, RD; 388. *A. vineale, C, 7, S; 711. *Asparagus officinalis, U, 7, RD; 405. Erythronium americanum, A, 5, B; 49. *Hemerocallis fulva, C, 7, RD; 719. *Lilium canadense, O, 5, LW; 593a. *L. superbum, U, 5, LW; 1005. *Medeola virginiana, O, 5, LW; 342. *Melanthium virginicum, O, 5, LW; 742. *Muscari racemosa, O, 7, S; 237. *Polygonatum biflorum, O, 4, LW, RD; 188, 338. *Smilacina racemosa, C, 5, LW; 198, 284. *Smilax bona-nox, O, 4, RD; 343. ***S. ecirrhata, O, 5, LW; 314, 1170. *S. glauca, C, 5, LW; 337. *S. herbacea, O, 5, LW; 307. *S. hispida, O, 5, LW; 751. S. rotundifolia, O, 5, LW; 358, 667. *Uvularia perfoliata, A, 5, LW; 301, 486. *U. pudica, U, 5, LW; 206. *Yucca filamentosa var. smalliana, O, 5, RD; 684.

ORCHIDACEAE: *Aplectrum hyemale, O, 5, LW; 304. *Corallorhiza odontorhiza, U, 4, UW; 1459. Cypripedium acaule, O, 5, UW; 251. Goodyera pubescens, O, 5, UW; 839. Habenaria clavellata, C, 5, LW; 905. *H. flava, U, 5, LW; 651. *H. lacera, O, 5, LW; 1476. Liparis lilifolia, R, 5, UW; 341. *Malaxis unifolia, R, 5, UW; 657. *Orchis spectabilis, R, 5, B; 334. *Spiranthes gracilis, U, 5, S; 1012. *S. grayi, U, 5, S; 1313. *S. ovalis, O, 5, LW; 1493. Tipularia discolor, U, 5, LW; 985.

POACEAE: Agrostis elliottiana, O, 4, RO; 430, 436. *A. hyemalis, O, 4, RO; 625. A. perennans, C, 4, B, RD; 972b, 1314. A. stolonifera, O, 7, RD, LW; 786, 920. *Aira caryophyllea, U, 7, RD; 502. A. elegans, O, 7, RD; 524. *Andropogon scoparius, O, 5, RD; 1574. *A. ternarius, C, 5, RD, RO; 1451, 1521. Anthoxanthum odoratum, C, 7, RD; 143. *Aristida curtissii, O, 5, RO; 1354, 1616. *A. dichotoma, O, 5, RD, RO; 1573a, 1615. *A. oligantha, O, 3, RD; 1330. *Arthraxon hispidus, O, 7, FP; 1546. Avena sativa, O, 7, S; 640. *Bromus catharticus, O, 7, FP; 543. B. japonicus, O, 7, RD; 713, 817. B. purgans, O, 5, LW; 760. Cinna arundinacea, C, 5, LW; 996, 1369. *Cynodon dactylon, C, 7, RD; 759, 886. Dactylis glomerata, A, 7, S; 712. *Danthonia sericea, O, 5, RD; 690. D. spicata, O, 3, LW; 661. *Digitaria ischaemum, O, 7, RD; 1339. *D. sanguinalis, O, 7, RD; 1023, 1377. Echinochloa crusgalli, O, 7, RD; 1193. *Eleusine indica, O, 7, FP, LW; 1249, 1407. **Elymus villosus, U, 5, FP; 883. E. virginicus, C, 5, RD; 942. Eragrostis capillaris, O, 5, LW; 1248, 1290. **E. curvula, O, 7, RD; 691, 1584. *E. hirsuta, O, 5, RO; 1522. *E. hypnoides, O, 4, FP; 1305. *E. pilosa, O, 7, RO, LW; 1351, 1581. E. spectabilis, O, 4, RD; 1235. *Erianthus alopecuroides, O, 5, S; 1316, 1612. *E. contortus, C, 5, RD; 1182. ****Eriochloa gracilis+, U, 4, RD; 1185. Festuca elatior, C, 7, FP; 546. *F. myurus, C, 7, RD, FP; 558, 606. F. obtusa, O, 5, LW; 599. F. octoflora, U, 3, RD; 464. Glyceria striata, O, 4, RO, LW; 447, 682. Hordeum pusillum, C, 4, RD; 396. Hystrix

patula, O, 5, RO; 714. *Leersia virginica, O, 5, FP, LW; 983, 1304. **Lolium multiflorum, O, 7, FP; 545. L. perenne, C, 7, RD; 816. Melica mutica, O, 5, UW; 386. *Microstegium vimineum, C, 7, LW; 1548, 1582. *Miscanthus sinensis, A, 7, RD; 1402. *Muhlenbergia schreberi, O, 4, LW; 1490, 1627. Panicum anceps, O, 5, RD; 1324. P. boscii, C, 5, LW, RD; 272, 830. *P. capillare, O, 3, LW; 1261. P. clandestinum, O, 5, FP; 541. P. commutatum, C, 5, LW, RD; 324, 465. *P. dichotomiflorum, O, 4, FP, RD; 1200, 1301. P. dichotomum, O, 5, LW; 493. P. laxiflorum, O, 4, RO; 445, 449. *P. polyanthes, O, 5, LW; 1055. P. scoparium, C, 4, RD; 856, 935. *P. sphaero-carpon, C, 4, RD; 887. P. stipitatum, O, 5, LW; 1218, 1368. *Paspalum dilatatum, O, 7, RD; 1263. *P. floridanum, C, 5, RD, RO; 948, 1534. *P. fluitans, U, 4, FP; 1300, 1540. *P. laeve, C, 5, RD; 1139a, 1220. P. pubescens, U, 5, RD; 1139b. *Poa annua, C, 7, RD; 114. P. autumnalis, O, 5, RO; 429, 433. P. compressa, O, 7, RD; 831. P. cuspidata, C, 5, B, LW; 19, 44. *P. pratensis, A, 7, RD, RO; 265, 619. *P. sylvestris, U, 5, LW; 232a. *P. trivialis, O, 7, LW, RD; 592, 760. Secale cereale, U, 7, RD; 1395. Setaria faberi, C, 7, RD; 978. *S. geniculata, O, 4, RD; 860. *S. glauca, C, 7, RD; 1194. S. viridis, O, 7, RD; 815b. *Sorghastrum nutans, U, 4, RD; 1394a, 1503. *Sorghum halepense, C, 7, RD; 806. *Sphenopholis intermedia, C, 3, LW, FP; 544, 602. *S. nitida, O, 5, LW; 264, 491. *S. obtusata, O, 4, LW; 597a. *Sporobolus vaginiflorus, O, 5, RD; 1605. Stipa avenacea, U, 5, RO; 617. Tridens flavus, O, 5, RD; 1142, 1264. *Tripsacum dactyloides, U, 4, RD; 1268. *Trisetum pensylvanicum, O, 5, LW; 638. Uniola latifolia, O, 5, RO, B; 761, 1101. *Zea mays, O, 7, RD; 924.

PONTEDERIACEAE: *Heteranthera reniformis, O, 4, AQ; 1482.

POTAMOGETONACEAE: *Potamogeton diversifolius, O, 4, AQ; 633. **P. epihydrus, A, 3, AQ; 650.

SPARGANIACEAE: *Sparganium americanum, A, 5, AQ; 725.

TYPHACEAE: Typha latifolia, O, 1, AO; 862.

XYRIDACEAE: *Xyris torta, U, 5, AQ; 1620.

DICOTYLEDONEAE

ACANTHACEAE: *Justicia americana, O, 5, FP; 971. *Ruellia caroliniensis, O, 5, RD; 870. *R. purshiana, U, 5, LW; 504.

ACERACEAE: *Acer negundo, O, 5, LW; 60, 542. *A. rubrum, C, 5, LW; 130. **A. saccharinum, O, 5, FP; 57, 560.

AIZOACEAE: *Mollugo verticillata, O, 7, RD; 1020.

AMARANTHACEAE: **Amaranthus hybridus, C, 7, RD; 1184. *A. spinosus, C, 4, FP; 1545. ***Iresine rhizomatosa, R, 5, FP; 1174.

ANACARDIACEAE: *Rhus copallina, O, 5, RD; 937. *R. glabra, O, 4, RD; 863. *R. radicans, A, 4, RD; 515. **R. vernix, O, 5, LW; 710.

ANNONACEAE: *Asimina triloba, A, 5, LW; 113.

APIACEAE: *Angelica venenosa, U, 5, LW, RD; 785, 851. **Chaerophyllum procumbens, O, 5, LW, FP; 234, 304. *C. tainturieri, A, 5, LW; 243. *Cicuta maculata, O, 4, RD; 936, 1242. *Conium maculatum, O, 7, FP, RD; 610, 764. *Cryptotaenia canadensis, U, 5, LW; 587, 753. *Daucus carota, C, 7, RD; 752. **Hydrocotyle ranunculoides, C, 4, AQ; 132. *Osmorhiza claytonii, A, 5, LW; 217. *Oxypolis rigidior, R, 5, LW; 223. Sanicula canadensis, O, 5, LW; 594, 789. **S. marilandica, O, 5, LW; 498. *S. smallii, O, 5, LW; 767. *Thaspium barbinode, O, 5, LW; 499.

APOCYNACEAE: *Apocynum cannabinum, O, 3, RD; 976. *Vinca minor, C, 7, RD; 20.

AQUIFOLIACEAE: Ilex decidua, U, 5, RO; 1104. *I. opaca, C, 5, LW; 1596. *I. verticillata, O, 5, LW; 659, 1478.

ARALIACEAE: *Aralia spinosa, O, 5, UW; 1388.

ARISTOLOCHIACEAE: *Aristolochia serpentaria, U, 5, LW; 239, 574. *Asarum canadense, A, 5, LW; 205. *Hexastylis virginica, U, 5, UW; 382.

ASCLEPIADACEAE: *Asclepias amplexicaulis, O, 5, RD; 509, 930. *A. incarnata, C, 5, LW; 1000, 1205. *A. syriaca, C, 5, RD; 688, 756. *A. tuberosa, O, 4, S; 706.

*A. variegata, O, 5, RD; 507. A. viridiflora, O, 4, RD; 809, 1137. *Matelea caroliniensis, U, 5, RO; 1638. *M. suberosa, U, 5, LW; 744.

ASTERACEAE: *Achillea millefolium, C, 7, RD; 390. *Ambrosia artemisiifolia, A, 4, RD; 1191. *A. trifida, O, 4, RD, LW; 1230, 1308. *Antennaria plantaginifolia, O, 5, LW; 99. *A. solitaria, O, 5, B; 204. *Anthemis arvensis, O, 7, RD; 182. *Arctium minus, O, 7, RD; 758. **Artemisia annua, U, 7, FP; 1418. Aster cordifolius, O, 5, FP; 1628. *A. divaricatus, O, 5, B; 1415. A. infirmis, C, 5, B, RD; 969, 1038. *A. lateriflorus, O, 5, LW; 1610. *A. patens, U, 5, S; 1592. A. paternus, O, 5, RD; 717, 1445. *A. pilosus, C, 5, RO, RD; 1312, 1528. *A. puniceus, O, 5, RD; 1499. *A. undulatus, O, 5, RD; 1589. *Bidens aristosa, C, 5, RD; 1029, 1225. *B. bipinnata, O, 4, RD; 1236. *B. frondosa, O, 3, RD; 1448. *B. tripartita, O, 7, LW; 1366, 1412. Carduus discolor, O, 5, RD; 1189. C. lanceolatus, O, 7, FP, RD; 1042, 1172. *Centaurea cyanus, A, 7, RD; 351. C. maculosa, O, 7, RD; 687. Chrysanthemum leucanthemum, A, 7, RD; 352. *Chrysogonum virginianum, U, 5, LW; 94. Cichorium intybus, O, 7, RD; 857. *Coreopsis lanceolata, C, 5, RD; 387, 469. C. verticillata, C, 5, RD; 689. *Eclipta alba, O, 6, FP; 1289. *Elephantopus carolinianus, O, 4, RD; 1015. E. tomentosus, C, 5, LW; 912. *Erechtites hieracifolia, O, 5, RD; 1392. *Erigeron annuus, C, 4, RD; 353, 475. *E. canadensis var. canadensis, A, 4, RD; 1199, 1391. ***E. philadelphicus, U, 5, FP; 329. *E. strigosus, C, 5, RD; 605. *Eupatorium album, U, 5, RD; 1381. *E. capillifolium, O, 5, RD; 1560. E. coelestinum, C, 4, FP; 1371. E. fistulosum, C, 5, RD; 1013, 1358. E. hyssopifolium, O, 5, RD; 1439. E. perfoliatum, O, 5, LW; 1213. *E. purpureum, O, 5, B; 750. E. rotundifolium, O, 5, RD; 1037, 1336. *E. rugosum, O, 5, LW; 1423. *E. sessilifolium, O, 5, LW; 1150. *Galinsoga ciliata, O, 7, FP; 799. *Gnaphalium obtusifolium, C, 5, RD; 1328. *G. purpureum, C, 4, RD; 262. *Helenium flexuosum, U, 5, RD, 1636. ***Helianthus annuus, O, 5, RD; 945. *H. atrorubens, O, 5, RD; 1158. *H. decapetalus, O, 5, LW; 1307. ***H. mollis, C, 5, S; 1594. *H. strumosus, O, 5, RD; 1265, 1387. *H. tuberosus, O, 5, RD; 1183. *Heterotheca mariana, O, 5, RD; 1134. *Hieracium gronovii, O, 5, RD; 1315, 1386. *H. scabrum, U, 5, RD; 1239. H. venosum, O, 5, RD; 174, 868. Hypochoeris radicata, C, 7, RD; 235. Krigia virginica, O, 5, RD; 159. Lactuca canadensis, C, 3, RD; 824. L. floridana, O, 5, LW; 1357. *L. scariola, O, 7, RD; 1024. Liatris squarrosa, C, 5, RD; 927, 1132. Mikania scandens, O, 4, RO; 1123. *Parthenium integrifolium, U, 5, RD; 412. *Polymnia uvedalia, A, 5, LW; 951. **Prenanthes altissima, O, 5, LW; 1598. *P. serpentaria, O, 5, RD; 1329, 1590. Pyrropappus carolinianus, O, 5, RD; 615. Rudbeckia hirta, C, 4, S; 754. *R. laciniata, O, 5, LW; 1257, 1371. *R. triloba, U, 5, RD; 943. *Senecio aureus, A, 5, LW; 134. *S. obovatus, O, 5, B; 202. *S. smallii, C, 5, RD; 377. *Silphium trifoliatum, U, 5, RD; 944. *Solidago altissima, A, 5, RD, LW; 1576, 1607. *S. bicolor, O, 5, B, RD; 891, 1444. *S. caesia, O, 5, RO; 1519. *S. erecta, O, 5, RD, LW; 1471, 1555. *S. gigantea, O, 5, B; 1283. *S. graminifolia, O, 5, RD; 1319, 1496. *S. juncea, C, 5, FP; 968. *S. nemoralis, A, 5, RD; 1393, 1595. S. odora, O, 5, RD; 1332. *S. pinetorum, A, 5, S; 1009, 1318. *S. rugosa, O, 5, RD, RO; 1495, 1622. Sonchus asper, O, 7, RD; 470. *Taraxacum officinale, C, 7, RD; 1634. *Verbesina alternifolia, A, 5, FP; 804, 965. *V. occidentalis, C, 5, LW, RD; 925, 1273. Vernonia glauca, O, 5, RD; 928, 1275. V. noveboracensis, O, 5, LW; 1208. *Xanthium strumarium, O, 7, FP; 1544.

BALSAMINACEAE: *Impatiens capensis, A, 5, FP; 1164. *I. pallida, C, 5, FP; 791.

BERBERIDACEAE: *Jeffersonia diphylla, O, 5, LW; 293. *Podophyllum peltatum, A, 5, LW; 209.

BETULACEAE: *Alnus serrulata, C, 5, LW; 1069, 1211. *Betula nigra, O, 5, LW; 1071. *Carpinus caroliniana, C, 5, LW; 407, 1547. *Corylus americana, O, 5, LW; 1464, 1480. *Ostrya virginiana, U, 5, B; 563.

BIGNONIACEAE: Campsis radicans, C, 5, RD; 692.

BORAGINACEAE: *Cynoglossum virginianum, U, 5, LW; 311. Echium vulgare, U, 7, RD; 1121. *Hakelia virginiana, U, 5, LW; 1274. *Lithospermum

arvense, O, 7, RD; 98, 397. *Myosotis macrosperma, A, 5, LW; 308. *M. verna, O, 4, RO; 252b.

BRASSICACEAE: *Alliaria petiolata, C, 7, RD; 169. *Arabidopsis thaliana, C, 7, RD; 71. *Arabis canadensis, U, 5, LW; 488. *A. laevigata, U, 5, LW; 118. *Barbarea verna, C, 7, RD; 103. *B. vulgaris, O, 7, RD; 170. *Brassica napus, C, 7, RD; 101. *Capsella bursa-pastoris, C, 7, RD, FP; 33, 330. *Cardamine bulbosa, O, 5, LW; 213. *C. concatenata, A, 5, LW, B; 21, 36. *C. hirsuta, A, 7, FP, RD; 25, 34. *C. parviflora var. arenicola, U, 1, RD; 160. *Draba verna, C, 7, RD; 32. *Erysimum cheiranthoides, C, 1, FP; 540, 1537. *Lepidium campestre, O, 7, RD; 138, 268. *L. virginicum, O, 3, RD; 255. *Raphanus raphanistrum, O, 7, RD; 535. *Rorippa islandica, O, 1, FP; 895. *Sisymbrium officinale var. leiocarpum, O, 7, FP; 269, 281. ***Teesdalia nudicaulis, O, 7, RD; 403. **Thlaspi arvense, O, 7, RD; 102, 391. *T. perfoliatum, A, 7, RD; 74.

CACTACEAE: *Opuntia compressa, A, 5, RO; 1373.

CALLITRICHACEAE: *Callitriche heterophylla, C, 4, AQ; 93, 133.

CAMPANULACEAE: *Lobelia cardinalis, U, 5, LW; 987. *L. inflata, O, 5, FP; 893. *L. puberula, U, 5, RD; 1375. *L. siphilitica, U, 5, FP; 1282. *L. spicata, O, 5, LW; 649. ***Specularia biflora, U, 4, RD; 537. *S. perfoliata, A, 4, RD; 417.

CANNABACEAE: *Humulus japonicus, A, 7, FP; 1294.

CAPRIFOLIACEAE: Lonicera japonica, A, 7, RD; 481. *Sambucus canadensis, O, 4, LW; 522. *Symphoricarpos orbiculatus, O, 5, LW, UW; 166, 793. *Triosteum perfoliatum, O, 5, S; 755. *Viburnum acerifolium, O, 5, LW; 485. *V. dentatum, C, 5, LW, UW; 359, 1143. *V. nudum, O, 5, WL; 737. *V. prunifolium, U, 5, RD, B; 53, 128.

CARYOPHYLLACEAE: *Agrostemma githago, O, 7, RD; 478. *Arenaria groenlandica var. glabra, A, 5, RO; 124, 196. **A. serphyllifolia, C, 7, RD, RO; 538, 623. *Cerastium glomeratum, C, 7, RD; 69. Dianthus armeria, O, 7, RD; 364. **D. prolifer, U, 7, RO; 1103, 1356. *Holosteum umbellatum, A, 7, RD; 79. *Lychnis alba, O, 7, RD, RO; 389, 425. ***L. coronaria, U, 7, RD; 693. *Sagina decumbens, O, 5, RD; 216. *Saponaria officinalis, O, 7, RD; 821. *Scleranthus annuus, O, 7, RO; 432. *Silene antirrhina, O, 4, RD; 392. *S. caroliniana, O, 5, RD; 186. *S. cucubalus, O, 7, RD; 406, 1135. *S. stellata, O, 5, B; 390. *Stellaria media, A, 7, RD; 1632. *S. pubera, C, 5, B; 22, 556.

CELASTRACEAE: *Euonymus americanus, O, 5, B; 294.

CHENOPODIACEAE: Chenopodium album, C, 7, RD, LW; 808, 1361. *C. ambrosioides, C, 7, RD; 1442, 1510.

CISTACEAE: ***Lechea intermedia, U, 5, RD; 1030b. *L. racemulosa, O, 5, RD; 1161, 1588. *L. tenuifolia, U, 5, RD; 1030b.

CONVOLVULACEAE: *Calystegia sepium, O, 1, RD; 554, 1196. **Cuscuta campestris, C, 4, RD; 926. *C. compacta, O, 5, LW; 1485. *C. gronovii, C, 5, LW; 1173, 1426. *Ipomoea hederacea, O, 7, RD; 954, 1195. *I. lacunosa, O, 5, RD; 1226. *I. pandurata, O, 5, RD; 859. *I. purpurea, O, 7, RD; 1229, 1433.

CORNACEAE: *Cornus amomum, O, 5, LW; 647, 1073. *C. florida, C, 4, UW; 107.

CRASSULACEAE: *Penthorum sedoides, O, 5, LW; 1149, 1466. ***Sedum sarmentosum, A, 7, RO; 434. *S. ternatum, A, 5, B; 219.

CUCURBITACEAE: *Sicyos angulatus, U, 5, B; 1411.

EBENACEAE: *Diospyros virginiana, O, 5, LW; 521.

ELAEAGNACEAE: ***Elaeagnus umbellata, O, 7, UW; 1036.

ERICACEAE: Chimaphila maculata, C, 5, UW; 724. *C. umbellata, O, 1, UW; 584. *Gaylussacia baccata, U, 5, RD; 271, 525. *Kalmia latifolia, U, 5, LW; 729. *Leucothoe racemosa, O, 5, LW; 420, 644. *Monotropa hypopithys, U, 4, UW; 656. *M. uniflora, O, 2, UW; 837. Oxydendrum arboreum, O, 5, UW; 739. *Pyrola rotundifolia var. americana, U, 1, LW; 636. *Rhododendron nudiflorum, O, 5, B, LW; 184, 192. *Vaccinium atrococcum, O, 5, LW; 96. *V. stamineum, U, 5, UW; 208, 250. *V. vacillans, O, 5, RD, UW; 147, 527.

EUPHORBIACEAE: *Acalypha gracilens, O, 5, RD; 1509, 1562. *A. rhomboidea, O, 5, RD, FP; 1288, 1500. *Croton glandulosus var. septentrionalis, O, 5, RD; 1163. *Crotonopsis elliptica, O, 5, RO; 1094. Euphorbia corollata, C, 5, RD; 322, 608. *E. cyparissias, O, 7, RD; 75. *E. maculata, O, 4, RD; 1018, 1311. **E. obtusata, O, 5, LW; 501.

FABACEAE: *Albizia julibrissin, O, 7, RD; 685. *Amphicarpa bracteata, O, 5, LW; 1246, 1477. *Apios americana, C, 5, LW; 1074. *Baptisia tinctoria, O, 5, RD; 514. *Cassia fasciculata, O, 5, RD, RO; 1119, 1337. *C. marilandica, O, 5, FP, PD; 953, 1551. *C. nictitans, O, 5, RD, LW; 995, 1049. *Centrosema virginianum, U, 5, RD; 1267. *Cercis canadensis, C, 4, LW; 1422. Clitoria mariana, O, 5, RD, UW; 822, 1162. ***Crotalaria mucronata, U, 7, RO; 1518. *Cytisus scoparius, J, 7, UW; 167. *Desmodium canescens, O, 5, RD, LW; 900, 1016. *D. glabellum, O, 5, LW, RD; 999, 1053. ***D. glutinosum, O, 4, LW; 771. *D. marilandicum, O, 5, LW; 1362. *D. nudiflorum, O, 5, LW; 828, 1087. *D. paniculatum, O, 5, S; 1321. *D. rotundifolium, O, 5, RD; 1376. *Galactia volubilis, O, 5, UW; 957. *Gleditsia triacanthos, O, 5, RD; 1570. *Lathyrus hirsutus, O, 7, FP; 559. *Lespedeza cuneata, O, 7, RD; 1269. *L. procumbens, O, 5, UW; 1222. L. repens, O, 5, RD; 480, 1334. *L. stipulacea, O, 7, RD; 1341a. *L. striata, O, 7, RD; 1341b. *L. virginica, O, 5, RD; 1035, 1338. *Medicago lupulina, C, 7, RD; 596. **M. sativa, C, 7, RD; 415. *Melilotus alba, O, 7, RD; 471. *M. officinalis, C, 7, RD; 413. *Pueraria lobata, A, 7, RD; 1233. *Robinia pseudo-acacia, O, 5, UW; 275. *Stylosanthes biflora, O, 5, RD; 858. *Tephrosia virginiana, C, 5, RD; 376. *Trifolium arvense, C, 7, RD; 414. *T. campestre, C, 7, RD; 370, 628. *T. dubium, C, 7, RO, RD; 253, 437. *T. pratense, C, 7, RD; 354. *T. repens, A, 7, RD; 369. *Vicia angustifolia, C, 7, RD; 350. *V. dasycarpa, C, 7, RD; 254, 400. *V. hirsuta, O, 7, FP, LW; 236, 361.

FAGACEAE: **Castanea dentata, U, 5, UW; 341. *C. pumila, O, 5, UW; 686. *Fagus grandifolia, A, 5, UW; 1552. *Quercus alba, A, 5, UW; 1556. *Q. coccinea, C, 5, UW; 1429, 1559. *Q. falcata var. falcata, O, 5, UW; 1557. *Q. marilandica, O, 5, UW; 1428. *Q. phellos, O, 5, UW; 510. *Q. prinus, C, 5, UW; 1403, 1446. *Q. rubra, O, 5, UW; 1553. *Q. stellata, O, 5, UW; 1280, 1558. *Q. velutina, O, 5, UW; 1460.

FUMARIACEAE: *Corydalis flavula, C, 5, B, UW; 50, 63. *Dicentra canadensis, A, 5, B, LW; 51, 109.

GENTIANACEAE: *Gentiana villosa, O, 5, LW; 1491. *Obolaria virginica, R, 5, LW; 503. *Sabatia angularis, O, 5, LW; 1256.

GERANIACEAE: *Geranium carolinianum, O, 3, RD; 270. *G. maculatum, U, 5, UW; 384. *G. molle, O, 7, RD; 283, 64.

HAMAMELIDACEAE: *Liquidambar styraciflua, C, 4, UW; 1431.

HYDROPHYLLACEAE: **Ellisia nyctelea, A, 5, FP; 288. **Hydrophyllum canadense, A, 5, FP; 797. *Nemophila microcalyx, C, 5, FP; 29, 38. *Phacelia dubia, O, 5, RO; 193.

HYPERICACEAE: *Hypericum gentianoides, O, 5, RO, RD; 865, 876. *H. hypericoides, O, 4, RD; 922. *H. mutilum, O, 5, RD; 867. *H. perforatum, O, 7, RD; 820. *H. prolificum, U, 5, B; 888. H. punctatum, O, 5, LW, RD; 768, 855. **H. stragalum, O, 5, RD; 829. ***H. virginicum, O, 5, RD; 1136. ***H. walteri, O, 5, LW; 1062.

JUGLANDACEAE: *Carya cordiformis, O, 5, LW; 1456. *C. ovalis, C, 5, UW; 1591. *C. tomentosa, C, 5, UW; 1437, 1568. *Juglans nigra, C, 5, RD; 1563.

LAMIACEAE: *Agastache nepetoides, U, 5, LW; 1426. ***Ajuga reptans, U, 7, RD; 161. *Collinsonia canadensis, U, 5, B; 1404. *Cunila origanoides, C, 5, RD; 1180. *Glecoma hederacea, O, 7, FP; 48. *Hedeoma pulegioides, O, 5, RD; 1040. **Isanthus brachiatus, O, 5, RD; 1169, 1425. *Lamium amplexicaule, A, 7, RD; 13. *L. purpureum, U, 7, FP; 41. *Lycopus americanus, O, 3, FP; 966. *L. virginicus, O, 5, LW; 1076. **Marrubium vulgare, C, 7, RD; 280. *Monarda fistulosa, O, 4, S; 757, 904. *Perilla frutescens, C, 7, LW; 1419. *Prunella vulgaris, C, 1, RD; 740. *Pycnanthemum incanum, O, 5, RD; 1014. *P. tenui-folium, O, 5, RD; 1131. Salvia lyrata, C, 5, LW; 259. *Satureja calamintha var. nepeta, O, 7, RD; 763, 1629. *S. vulgaris, O, 7, LW, RD; 825, 903.

*Scutellaria elliptica, O, 5, FP; 549. *S. integrifolia, O, 5, RO, LW; 704, 716. *S. lateriflora, O, 3, LW; 1001. ***S. ovata, O, 4, B; 565. *Teucrium canadense, O, 3, RD; 902. *Trichostema dichotomum, C, 5, RD; 1323.

LAURACEAE: *Lindera benzoin, C, 5, LW; 1479. *Sassafras albidum, C, 5, LW; 1571.

LENTIBULARIACEAE: ***Utricularia biflora, U, 5, AQ; 1067.

LINACEAE: *Linum striatum, O, 5, RO; 916. L. virginianum, O, 5, RD; 1017.

LOGANIACEAE: *Polypremum procumbens, O, 4, RO, RD; 874, 1327.

LORANTHACEAE: *Phoradendron serotinum, U, 5, UW; 1633.

MAGNOLIACEAE: *Liriodendron tulipifera, C, 5, LW; 303. ***Magnolia virginiana, U, 5, LW; 73.

MALVACEAE: **Abutilon theophrastii, O, 7, RD; 1159. *Hibiscus moscheutos, C, 5, LW; 1072. **H. syriacus, O, 7, RD; 1245. *Malva neglecta, C, 7, RD; 282. *Sida spinosa, O, 7, RD, LW; 1025, 1197.

MELASTOMATACEAE: *Rhexia mariana, C, 5, RD; 774, 1322.

MENISPERMACEAE: *Menispermum canadense, U, 5, B; 191.

MORACEAE: *Morus rubra, O, 5, UW; 474.

NYMPHAEACEAE: *Nuphar luteum, A, 4, AQ; 726. Nymphaea odorata, O, 4, AQ; 731.

NYSSACEAE: *Nyssa sylvatica, O, 5, LW; 736.

OLEACEAE: *Chionanthus virginicus, O, 5, B; 534. *Fraxinus pennsylvanica, O, 5, LW; 557. ***Ligustrum obtusifolium, C, 7, LW, RD; 347, 360. *L. sinense, O, 7, RD; 609.

ONAGRACEAE: *Circaea lucetiana ssp. canadensis, C, 1, LW; 850. *Epilobium coloratum, O, 5, FP, RD; 1032, 1178. *Gaura biennis, O, 5, RD; 1572. *Ludwigia alternifolia, C, 5, RD; 961, 1259. **L. decurrens, O, 4, RD; 1271. *L. palustris, O, 4, AQ; 696. *Oenothera biennis, O, 4, RD; 975, 1238. *O. laciniata, O, 4, RD; 399, 455.

OROBANCHACEAE: *Conopholis americana, C, 5, B; 609. *Epifagus virginiana, O, 5, B; 3, 1279. *Orobanche uniflora, R, 3, B; 223.

OXALIDACEAE: *Oxalis dillenii, O, 4, RD; 1022. **O. florida, O, 5, UW; 670. *O. stricta, O, 4, RD; 993. *O. violacea, U, 5, LW; 240.

PAPAVERACEAE: **Papaver dubium, O, 7, RD; 402. *Sanguinaria canadensis, C, 5, B; 18.

PASSIFLORACEAE: *Passiflora incarnata, U, 5, RD; 906. *P. lutea, O, 5, RD; 1190.

PHRYMACEAE: *Phryma leptostachya, O, 2, LW; 775.

PHYTOLACCACEAE: *Phytolacca americana, C, 5, RD; 528.

PLANTAGINACEAE: *Plantago aristata, C, 3, RD; 463. P. lanceolata, C, 7, RD; 274. *P. rugelii, C, 5, RD; 762. *P. virginica, C, 3, RD; 146.

PLATANACEAE: *Platanus occidentalis, O, 5, LW; 1192.

POLEMONIACEAE: *Phlox divaricata, A, 5, LW; 228. *P. subulata, O, 5, RD; 88, 162.

POLYGALACEAE: ***Polygala mariana, U, 5, RD; 1374, 1447.

POLYGONACEAE: *Polygonum arifolium, C, 5, LW; 1214, 1484. **P. aviculare, C, 7, RD; 536, 811. **P. cespitosum var. longisetum, C, 7, FP; 1293, 1539. *P. convolvulus, O, 7, RD; 810, 1348. **P. hydropiper, O, 7, LW; 1210c. *P. hydro-piperoides, O, 4, LW; 1272a. *P. lapathifolium, O, 6, FP; 1296. *P. pensyl-vanicum, O, 5, LW; 1079, 1292. **P. persicaria, O, 7, RD; 655. **P. punctatum, C, 4, FP, LW; 878, 1286. *P. sagittatum, A, 5, LW; 1483. *P. setaceum, O, 5, LW, RD; 847, 998. *Rumex acetosella, O, 7, RD, RO; 145, 451. *R. crispus, C, 7, FP; 570. *R. obtusifolius, O, 7, FP, LW; 803, 896. *Tovara virginiana, U, 2, LW; 882.

PORTULACACEAE: *Claytonia virginica, A, 5, LW; 11. *Portulaca grandiflora, U, 7, RO; 1529. *P. oleracea, O, 7, RO; 1531. *Talinum teretifolium, C, 5, RO; 530.

PRIMULACEAE: Anagallis arvensis, U, 7, RD; 473. *Lysimachia ciliata, O, 5, FP, LW; 572, 676. *L. quadrifolia, O, 5, B, RD; 349, 568. **L. terrestris, U, 5, LW; 660.

RANUNCULACEAE: *Aconitum uncinatum, U, 5, LW; 648. *Anemone virginiana,

0, 5, UW; 777. *Cimicifuga racemosa, C, 5, LW; 770. Clematis ochroleuca, U, 5, RD, LW; 179, 247. *C. virginiana, O, 5, LW; 1204. *Delphinium ajacis, C, 7, RD; 279. *Hepatica americana, U, 5, UW; 2. *Ranunculus abortivus, O, 3, LW, RD; 72, 197. *R. bulbosus, O, 7, RD; 175. *R. hispidus, O, 5, UW; 171. **R. micranthus, A, 5, LW; 229. **R. parviflorus, U, 7, RD; 163. *R. pusillus, A, 3, FP, LW; 319, 505. *R. recurvatus, C, 5, LW; 227. *Thalictrum dioicum, U, 5, B; 52. *T. polygamum, O, 5, RO; 705. *T. thalictroides, C, 5, B; 54.

RHAMNACEAE: Ceanothus americanus, O, 5, UW, RD; 411, 512.

ROSACEAE: *Agrimonia parviflora, O, 4, FP, LW; 967, 1258. A. pubescens, O, 5, LW; 832, 901. *A. rostellata, O, 5, LW; 884. *Amelanchier arborea, U, 5, LW, RO; 59, 189. *Duchesnea indica, C, 7, RD; 120. *Fragaria virginiana, O, 5, RD; 89. *Geum canadense, O, 5, LW; 738, 779. *G. virginianum, U, 5, LW; 778. *Potentilla canadensis, C, 5, LW, UW; 91, 266. *P. norvegica, U, 1, RO; 701. *P. recta, O, 7, RD; 404. *Prunus avium, U, 7, UW; 116. *P. hortulana, O, 5, UW; 7n. **P. persica, U, 7, UW; 77. *P. serotina, C, 4, RD; 183. **Pyrus communis, U, 7, RD; 68. *Rosa caroliniana, O, 5, RD; 416, 460. *R. multiflora, O, 7, FP; 337b. *R. palustris, O, 5, LW; 733. **R. wichuraiana, O, 7, RD; 508. *Rubus allegheniensis, O, 5, FP; 292, 346. *R. flagellaris, U, 5, LW; 148. *R. occidentalis, O, 5, LW; 476, 611.

RUBIACEAE: Cephalanthus occidentalis, O, 4, LW; 720, 845. *Diodia teres, O, 5, RD; 864, 1026. D. virginiana, C, 5, RD; 962, 1117. *Galium aparine, A, 1, LW; 339, 582. G. circaezans, C, 5, LW; 581, 784. **G. obtusum, C, 5, LW; 484. G. pilosum, C, 5, LW, RO; 917, 952. *G. tinctorium, O, 3, LW; 728, 1050. *G. triflorum, O, 1, FP, LW; 827, 1284. *Houstonia caerulea, O, 5, B; 55. *H. longifolia, O, 5, LW; 782. *H. purpurea, C, 5, LW; 302. *Mitchella repens, C, 5, UW; 80. ***Sherardia arvensis, C, 7, RO; 531.

SALICACEAE: **Populus alba, O, 7, RD; 516. *P. deltoides, O, 5, RD; 654. **P. grandidentata, O, 5, UW; 526. **Salix nigra, C, 5, RD; 1635.

SAURURACEAE: Saururus cernuus, A, 5, LW; 664.

SAXIFRAGACEAE: **Chrysosplenium americanum, C, 5, LW; 82. *Heuchera americana, O, 5, LW; 296. *Hydrangea arborescens, O, 5, B; 566. *Itea virginica, O, 5, LW; 643, 1070. **Philadelphus inodorus, O, 5, RD; 477. *Saxifraga virginiensis, C, 5, B; 31.

SCROPHULARIACEAE: *Agalinis purpurea, U, 4, RO; 1505. *Aureolaria pedicularia, O, 5, RD; 1179. *A. virginica, O, 5, RD; 694. *Chelone glabra, O, 5, AQ; 1526. *Gratiola neglecta, O, 5, LW; 578. *G. pilosa, O, 5, RD; 1241. *G. virginiana, O, 5, AQ; 421. *G. viscidula, O, 5, LW; 634, 1147. *Kickxia elatine, R, 7, RD; 805. *Linaria canadensis, O, 4, RO; 194, 529. *Lindernia dubia, O, 4, AQ; 1056, 1306. *Mimulus alatus, O, 5, LW; 1058. *Paulownia tomentosa, O, 7, UW; 108. *Penstemon canescens, O, 5, RD; 422, 461. *Scrophularia marilandica, C, 5, LW; 1550. Verbascum blattaria, U, 7, RD; 472. *V. thapsus, C, 7, RD; 1122. ***Veronica agrestis, U, 7, RD; 195. *V. arvensis, C, 7, RD; 104. *V. hederaefolia, O, 7, FP; 28. *V. officinalis, O, 7, LW; 577. *V. peregrina, A, 4, RD; 106, 393.

SIMAROUBACEAE: *Ailanthus altissima, C, 7, UW; 1430.

SOLANACEAE: *Datura stramonium, O, 7, RD; 1027. *Lycium halimifolium, U, 7, RD; 1506. *Physalis virginiana, O, 5, RD; UW; 669, 1168. *Solanum americanum, U, 5, FP; 1541. S. carolinense, C, 5, RD; 372.

STAPHYLEACEAE: *Staphylea trifolia, O, 5, LW; 573.

TILIACEAE: *Tilia americana, U, 5, UW; 285.

ULMACEAE: *Celtis occidentalis, O, 5, RO; 873. *Ulmus alata, U, 5, LW; 244. *U. americana, O, 5, FP; 56. *U. rubra, O, 5, UW; 14.

URTICACEAE: *Boehmeria cylindrica, O, 4, LW; 848. *Laportea canadensis, A, 5, FP; 1176. *Pilea pumila, O, 5, LW; 1577.

VALERIANACEAE: *Valerianella locusta, C, 7, RO; 199, 252c. *V. umbilicata, O, 5, RO; 252a.

VERBENACEAE: *Verbena urticifolia, O, 5, UW; 749.

VIOLACEAE: *Viola affinis, C, 5, LW; 140. *V. arvensis, U, 7, S; 652 *V. cucullata, C, 5, LW; 233, 241. V. eriocarpa var. leiocarpa, A, 5, LW; 37, 110. V. fimbriatula, C, 5, RD; 40, 149. *V. palmata var. palmata, C, 5, UW; 242. V. palmata var. sororia, O, 5, RD; 187. V. palmata var. triloba, U, 5, RD; 154. V. primulifolia, O, 5, RD; 157. *V. rafinesquii, C, 7, RD, LW; 35, 100. *V. sagittata, C, 5, RD; 153, 158. *V. striata, C, 5, FP; 224.

VITACEAE: *Parthenocissus quinquefolia, A, 4, RO; 424. *Vitis aestivalis, O, 5, UW; 458. *V. baileyana, O, 5, B; 286. *V. cinerea, O, 5, UW; 520. *V. labrusca, O, 5, RO; 453. *V. rotundifolia, O, 5, UW; 1325. *V. vulpina, A, 5, LW; 798.

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Additional Abstracts

Fifty-Ninth Annual Meeting of the Virginia Academy of Science
May 12-15, 1981, Old Dominion University

The abstracts below were omitted
from the Proceedings issue.

PETROLOGY OF AN ANDESINE ANORTHOSITE BODY NEAR MONTPELIER, VA. K. L. Bice*. Dept. of Geology, College of William and Mary, Williamsburg, VA 23185.

The mineralogy, textures and chemical composition of an andesine anorthosite near Montpelier, VA. were studied to characterize the intrusive and determine the effects of metamorphism of the body.

The anorthosite body consists of two phases: a coarse, gray nonfoliated anorthosite and a white highly granulated, foliated anorthosite. The essential minerals of the coarse or primary anorthosite were plagioclase (An36), pyroxene, quartz and apatite before later alteration introduced amphibole and chlorite as a pseudomorphic replacement of the pyroxene. The andesine occurs in two textural varieties: antiperthite and myrmekite. Accessory minerals include ilmenite, rutile, garnet, biotite and sphene. The granulated anorthosite is composed of plagioclase (An34), quartz, microcline and biotite.

The anorthosite was probably emplaced in the schist through passive intrusion during the pC. After crystallization the area was subjected to intense regional metamorphism. Granulation and recrystallization of the primary anorthosite produced the granulated anorthosite.

FOSSIL FISH AS PALEOCLIMATIC INDICATORS FOR LATE CENOZOIC SEDIMENTS, WESTERN SNAKE RIVER PLAIN, IDAHO. P.G. Kimmel* Geology Dept., George Mason Univ., Fairfax, VA 22110

Late Miocene and late Pliocene cooling trends can be recognized using changes in fossil fish faunas of the Chalk Hills and Glenns Ferry Formations. The fossil fish inhabited successive freshwater rift lakes in southwest Idaho. Each fish fauna can be divided into a group of warm-water taxa (a catfish, Ictalurus; a sunfish, Archoplites; and the Minnows Orthodon and Mylopharodon) and a group of cool-water taxa (the salmonids, the sculpins, and the minnows Acrocheilus and Mylocheilus). These groups are defined using the present distributions and habitats of the closest living relatives. When the relative percentages of these two groups are compared in thirteen collections from seven different stratigraphic levels, they show an increasing dominance of the faunas by cool-water taxa at the end of the Miocene. Deposition then ended for a period of several million years. The lowest collections in the Glenns Ferry Formation are also dominated by cool-water taxa. Somewhat higher a single warm-water dominated fauna is followed by collections containing even more cool-water taxa than before, indicating a strong cooling trend at the end of the Pliocene. These data agree with world-wide cooling trends and are supported by fossil mammal and pollen evidence from the Glenns Ferry Formation.

EVALUATION OF PERCOLL AS A STABILIZING MEDIUM FOR VIRUS PLAQUE ASSAY. M. C. Franko, G. R. Bryson, and S. R. Webb. Va. Commonwealth Univ., Richmond, VA 23284.

Agar has been traditionally used as a stabilizing agent in viral plaque assays. Since potential problems with maintenance of critical temperature is required with agar, methyl cellulose is now commonly used as a stabilizing agent. Percoll, a PVP-coated silica preparation, is a new medium for density gradient separation. Since it offers several advantages over agar or methyl cellulose, it was evaluated as an alternative stablizing agent for plaque assay.

The system chosen for comparison of methyl cellulose and Percoll was Coxsackie virus B4 (CB4) and Monkey kidney (BGM) cells. Methyl cellulose and Percoll were compared for efficiency of plating and plaque size relative to equally viscous and dense solutions. At an equal viscosity of 7.67 cP, methyl cellulose (0.07%) did not restrict diffusion of newly released virions and thus did not produce definitive plaques. At an equal density of 1.115 g/ml., methyl cellulose (0.63%) had the same plaque size and was equally efficient. We concluded that Percoll can be substituted for other stabilizing agents and that it offers several advantages. Percoll has a low viscosity, low osmolarity, it is non-toxic, is supplied as a sterile medium which can be resterilized by autoclaving, and has a long shelf life. Its one disadvantage is its cost.

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AN ENZYMATIC POTENTIAL FOR ESTABLISHING CYCLIC AMP GRADIENTS DURING PATTERN FORMATION IN DICTYOSTELIUM DISCOIDEUM. R. K. Merkle and C. L. Rutherford*, Dept. of Biology, VPI&SU, Blacksburg, VA. 24061. Cyclic AMP is known to function as the chemotactic signal during aggregation of single-celled amoebae of the cellular slime mold Dictostelium discoideum. Evidence from several laboratories has accumulated suggesting that cAMP also acts as a regulatory molecule during Dictyostelium multicellular differentiation. We have utilized microtechniques and an ultrasensitive radioimmunoassay in the localization and biochemical analysis of adenylate cyclase, the cAMP synthetic enzyme in order to test for the potential to establish cAMP gradients. Adenylate cyclase activity was localized in the pre-spore cells of the culminating individual with no activity detectable in the pre-stalk region. We found an increasing gradient of activity from the tip of the individual to the base of the spore mass. The same localization was apparent in earlier stages of the life cycle. Adenylate cyclase activity from mass cultures has been characterized. We found that a divalent cation is required for enzyme activity and that with Mn^{+2} the activity is 8-fold greater than with Mg^{+2}. Typical mammalian adenylate cyclase modulators, such as Gpp(NH)p and NaF did not activate the Dictyostelium enzyme. The adenylate cyclase localization data along with that from 5'AMP nucleotidase and cAMP phosphodiesterase indicate that the potential exists for establishing gradients of the suspected morphogen, cAMP, during pattern formation in Dictyostelium.

OBITUARIES

Clyde Y. Kramer
1925 - 1981

Dr. Clyde Y. Kramer, Professor of Statistics, VPI&SU, died June 8, 1981 at the age of 56. On the Virginia Tech faculty since 1951, he became director in 1957 of the Statistical Consulting Laboratory, serving the Agricultural Experiment Station. He served as head of the Department of Statistics during 1972-73, and had been undergraduate coordinator for the Department since 1976. He was widely recognized as one of the nation's outstanding statistical consultants, and his unique teaching abilities were recognized through invitations to teach short courses throughout the United States and in Europe and the Far East. His reserch publications have been highly acclaimed and widely cited. He was a member of numerous professional societies and had been elected as a Fellow of the American Statistical Association, the International Statistical Institute, and the American Association for the Advancement of Science. He served on the Governor's Committee for the Handicapped, and worked actively with the Virginia Junior Academy of Science, and was a Fellow of the Virginia Academy of Science.

Arthur Ballard Massey
1889 - 1981

Arthur Ballard Massey, Emeritus Professor of Biology, VPI&SU, died at his home in Blacksburg, October 15, 1981. Professor Massey was born at Miller's School, Virginia, on January 10, 1889. He received his B.S. degree in 1909 from North Carolina State College where his father was employed as a botanist. He served as an instructor of Botany at Clemson College from 1910 to 1913 and was an Assistant Professor of Botany at Alabama Polytechnic Institute and the Alabama Agricultural Experiment Station from 1913 to 1918. When he came to Virginia Polytechnic Institute to serve as an Associate Professor of Biology in the Virginia Agricultural Experiment Station. He earned his M.S. degree at VPI in 1928. From 1935 to 1959 he was the Botanist with the VPI Wildlife Unit and in 1956 became Professor of biology. He held these positions until he retired in 1959. Lynchburg College awarded him the honorary D. Sc. in 1956. Professor Massey started accumulating specimens of the state flora when he joined the VPI faculty in 1918 and began to organize a herbarium which by his retirement approached 40,000 specimens. In 1961 the Board of Visitors of VPI located the collection permanently in Derring Hall and named it the Massey Herbarium in his honor. Professor Massey was one of those who were instrumental in the establishment of the Mountain Lake Biological Station and the Virginia Flora Committee of The Virginia Academy of Science, which committee he served as chairman for almost 40 years. He was instrumental along with Drs. Ruskin Freer and R. P. Carroll and others in organizing the botanical journal *Claytonia,* which was the predecessor to the Virginia Journal of Science. Though he was well known for his various articles on Virginia botany in scientific journals, and his booklets on various groups of Virginia plants, such as his guide to ferns of Virginia, his best known work in his 1960 book, *Virginia Flora,* a checklist with notes on distribution by county of over 3500 species and varieties of vascular plants recorded from Virginia. An attender of Virginia Academy of Science meetings well into his 80's, Professor Massey was an Honorary Life Member of the Academy.
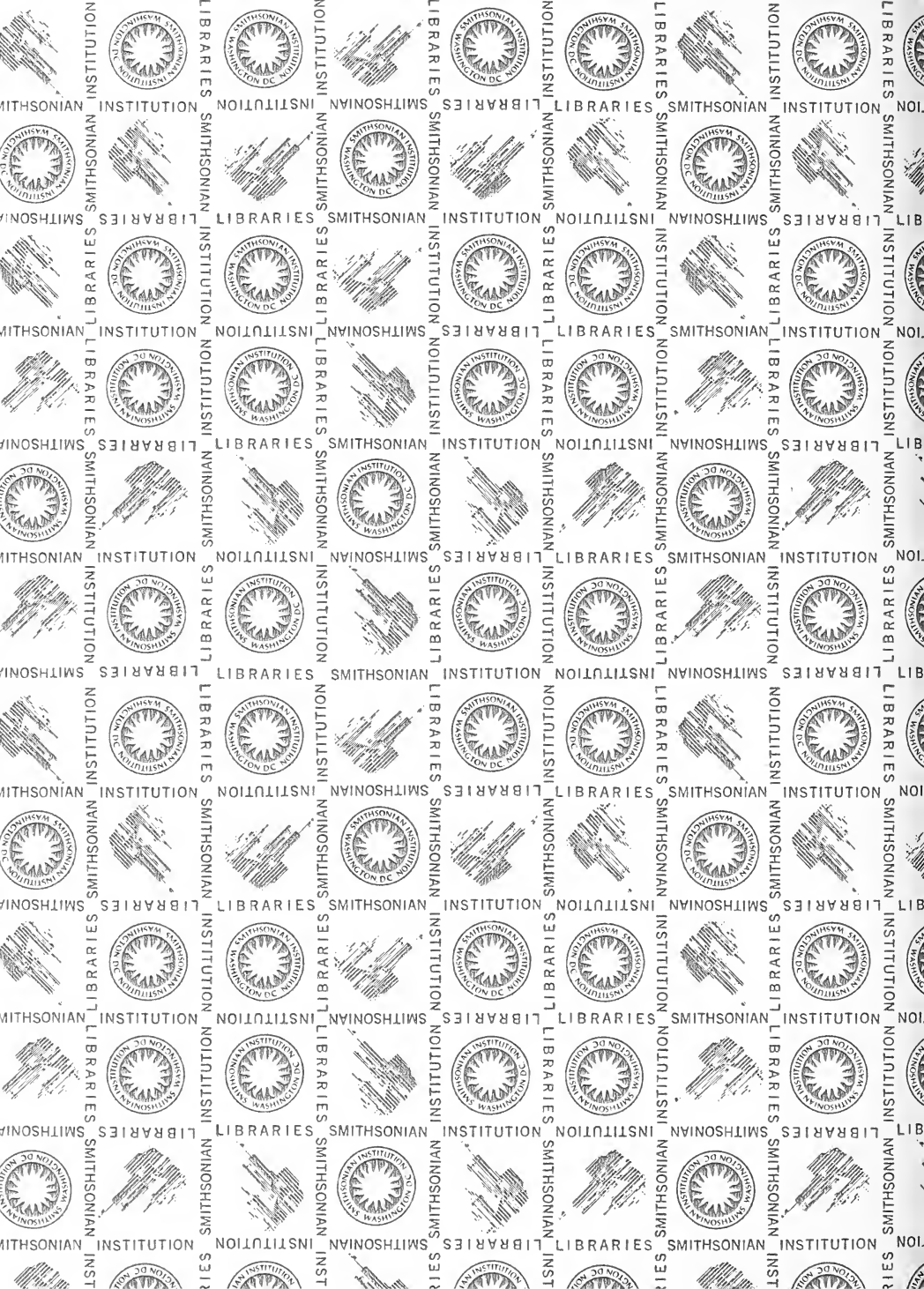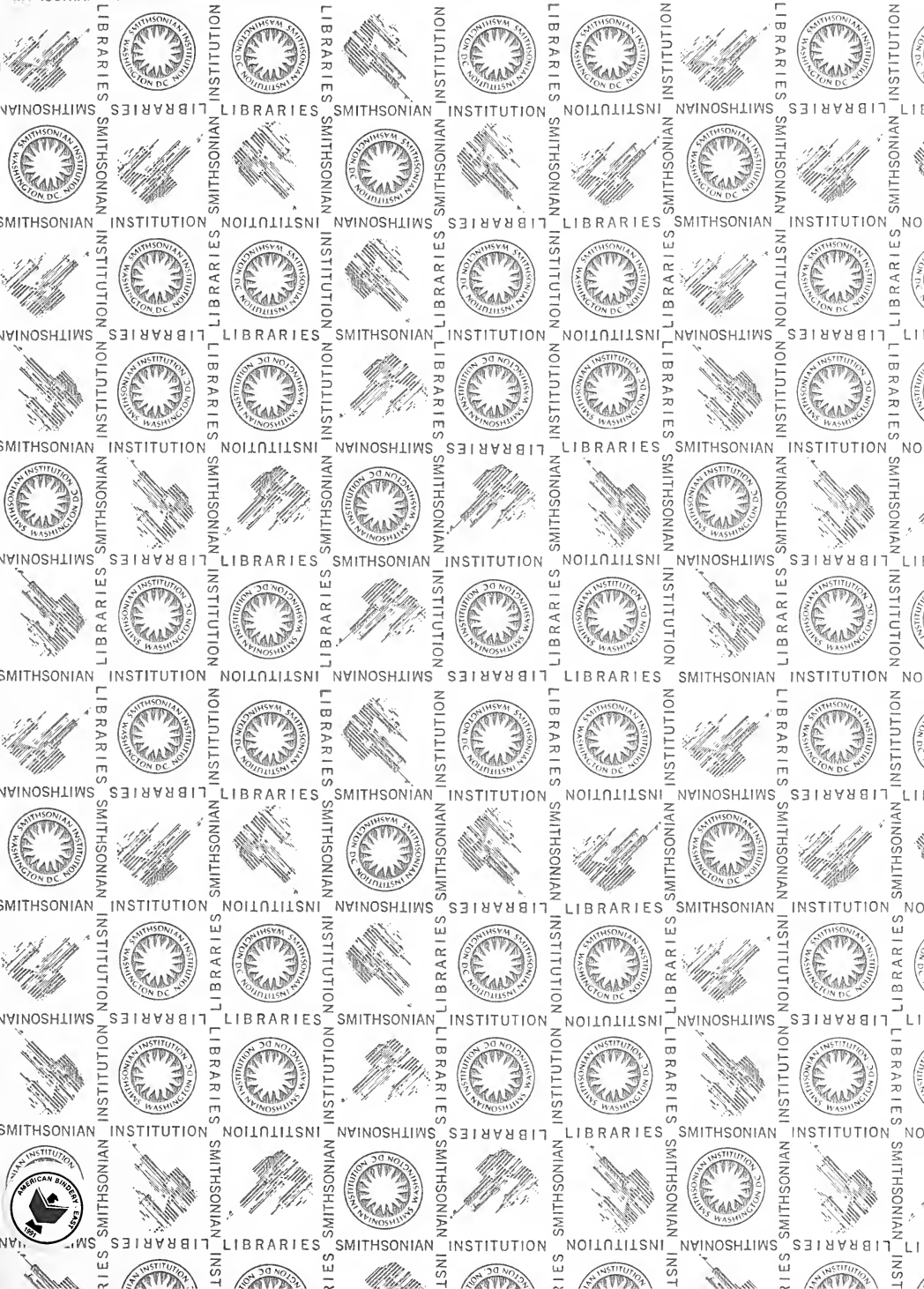
Martha K. Roane

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